The Beef COW - CALF Manual

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AGRICULTURE
Beef Cattle and Sheep Branch

Foreword

The Beef Cow-Calf Manual, first printed in 1975 with revisions in 1981, has been well received by Alberta cattle producers with thousands of copies distributed through the offices of district agriculturists.

The present revision is an attempt to keep pace with recent technological advances. This has involved the revision and expansion of existing sections as well as the inclusion of a new section on insect pests affecting livestock. The basic organization consists of eight sections: an overview of the beef industry, management of the herd, nutrition, breeding, animal health, insects, handling facilities and range and pasture management.

The purpose of this manual is to provide a general overview of the beef cattle industry as well as husbandry practices and technical information. The section on management has been expanded considerably and includes calving and reproduction. Feeding guidelines for different classes of cattle are described in the nutrition section. The breeding section deals with the advantages and disadvantages and development of different breeding systems. The animal health section provides a comprehensive overview of cattle diseases including a calendar to use as a reminder for control practices. The final two chapters give information on handling facilities and range and pasture management.

This manual is written with the intention of establishing basic principles. It is not a recipe book; for example, the reader will not find dosages for treatment in the health and insect sections. Doses vary from product to product and must be derived from the labels or used on the recommendation of a veterinary practitioner. Because technology is rapidly changing, additional information on specific topics will be frequently made available through factsheets which can be updated on an annual basis.

I trust this manual will be a useful reference for Alberta cattle producers.

Ron Weisenburger, Head
Beef Cattle and Sheep Branch

Acknowledgments

Numerous staff from the Animal Industry Division, the Plant Industry Division, and the Animal Health Division reviewed the text and prepared revisions to include new developments in technology and practice since the last major revisions in 1981. The Beef Cattle and Sheep Branch gratefully acknowledges the valuable assistance of each of the other branches, staff and former staff of the department who have made contributions to this and past editions of the manual.

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Nature of the Beef Industry and Production Costs

Nature of the Beef Industry

Importance of beef production

The cow-calf and beef finishing enterprises on Alberta farms and ranches together make up a very significant portion of Alberta's agriculture industry. The cow-calf business, which in earlier years was concentrated mainly in the south, is now found throughout the province. The largest individual herds are still found in the south. Significant increase in cattle numbers have occurred in central and northern Alberta during the last three decades.

The beef feeding industry consists of both farm and nonfarm feedlot operations. Farm feedlots range in size from small enterprises using surplus feed grains and offseason labor to relatively large feedlots that provide the major source of farm income. Nonfarm feedlots are specialized cattle feeding operations. They generally purchase all their feed requirements and either purchase feeder cattle or custom feed cattle for producers and private businessmen on a fee for service basis.

The diversification of farms through cattle production has helped to maintain farm income levels through periods of low world grain prices and low delivery quotas. In addition, it has proven to be a good hedge against such farming hazards as frost and hail. It is a means of using land that is not arable, whether by reason of low precipitation, stoniness, poor soil conditions or rough topography.

Data from Alberta Agriculture *Farm Cash Receipts and Expenses* show the amount of income generated by the beef industry. In 1987, the returns from cattle and calves were estimated at $1.204 billion or 30.7 per cent of farm cash receipts in Alberta. In comparison, wheat accounted for 13.8 per cent and hogs 7.2 per cent.

Location of beef production

There were 3.79 million beef cows and breeding heifers on Canadian farms in July 1987. Of these, 1.57 million head or 41.4 per cent were located on Alberta farms. In contrast, 178,000 head or 8.6 per cent of Canada's female dairy stock were located in Alberta. The presence of over two fifths of the total beef breeding herd in Alberta makes this province the heart of the beef industry. Reported slaughter volumes at federally inspected plants further support this statement.

Table 1
Live cattle slaughtered in Canada or exported to the US for slaughter, 1987

	No. head slaughtered	% Canadian total
Alberta	1,254,074	39.6
Saskatchewan	294,882	9.3
Manitoba	270,485	8.5
Prairies	1,819,441	57.4
Ontario	880,653	27.8
Total Canada	3,169,359	

Source: *Canada Livestock and Meat Trade Report, Agriculture Canada.*

Possibilities for future growth

The size of the beef market is determined by the number of beef consumers, their income, the amount of money that they spend on beef and the price of beef. If beef prices are stable relative to other items in the consumers' budget, the major opportunity for growth in the beef market lies with an increase in population. This could result either from population growth in traditional markets or an increase in exports.

The means of expansion are:

- expanding the beef breeding herd
- reducing calf slaughter and directing more calves to the feedlot
- feeding cattle to heavier weights
- improving calving percentages.

Feeding to heavier weights and reducing calf slaughter are the quickest ways to cause an increase. However, there are definite limits as to how much the beef supply can be increased using either of these methods. Improving calving percentages is a good idea in theory, but in practice it is difficult to bring about a large improvement throughout the entire industry. There can be dramatic changes in individual herds, but the net effect on the whole industry tends to be relatively small. Future expansion will depend to a large extent on the rate of breeding herd expansion.

Expansion of the breeding herd takes place when profit incentives are present in all phases of the beef industry. As soon as feedlots, packers or retailers feel the cost-price squeeze, it is reflected in the actions of cow-calf operators, who in turn stop expanding production.

Expansion of the breeding herd depends on an adequate land base. Canada is fast approaching the point where an increase in cow numbers will depend on how competitive the cow-calf industry is with other types of agricultural production. If cattle cannot compete economically for land, expansion will be limited. There may still be a few alternatives such as:

- further development of marginal land in fringe areas
- better management of existing range and farm land
- improvement of range management programs
- utilization of rough land on some farms - utilization of more crop aftermath
- improvements in forage handling and harvesting methods.

The beef cycle

North American beef production is subject to a price and supply cycle of about 10 years. Cattle prices tend to be lowest when beef supplies are largest and highest when beef supplies are smallest. Higher prices improve the profits of cattle producers and encourage herd expansion. Lower prices result in losses and encourage producers to cut back production.

When prices are high and profits are good, producers expand their herds by reducing the rate at which they cull older cows and by retaining a larger percentage of heifers for breeding. This action even further reduces the low supply of beef that is causing the higher prices. By the time beef prices reach the point at which consumers cut back on their purchases and prices level out, the breeding herd has overexpanded.

As soon as prices decline in response to the increase in beef supplies, and profits turn to losses, cows are culled more rigorously and a larger percentage of heifers are marketed as beef rather than retained for breeding. Thus at the very time when beef supplies are burdensome, the action of producers to reduce their herds temporarily adds to the problem. Beef prices then decline further to encourage an increase in consumer purchases to absorb the temporary increase in supplies. By the time consumption has increased to absorb the increased supplies, the temporary increase in beef supplies from culled cows and increased heifer slaughter is reduced, and prices begin to improve.

The beef cycle has a particularly important bearing on new producers entering the business because they often are more dependent on borrowed capital and have a smaller equity cushion to see them through periods of low cattle prices. A period of high interest rates would increase the financial strain on these cattle producers.

The challenge for cattle producers is to anticipate price cycles and adjust their production accordingly. Producers face two problems in meeting this challenge. First, there is a two to three year lag between the time the decision to adjust the size of the breeding herd is made and the time when actual change in the beef supply occurs. Second, the time to cut back production is often when prices are highest and cash flow most favorable; conversely the time to expand is often when prices are lowest and cash flow is least favorable.

Modern communication systems and world-wide monitoring of beef supplies should provide enough information on which to base decisions. The most difficult part is for the thousands of producers to take the right action at the right time so that the net result is a continuing favorable supply-demand balance. Two key indicators regarding future supply prospects are the number of cows being slaughtered and the ratio of heifers to steers in the beef kill.

Market information is available from the Market Analysis Branch of Alberta Agriculture, CANFAX and BEEF WATCH from the Canadian Cattlemen's Association, The Alberta Cattle Commission and many farm papers. For a detailed discussion of the cattle cycle obtain a copy of the Canadian Cattlemen's Association publication THE CATTLE CYCLE.

Beef trade between Canada and the United States is important to Alberta cow-calf producers. This trade flow is a major stabilizing factor, providing an effective floor price at the level of the North American market.

The North American beef market

The Canadian cattle industry normally operates in a North American market. The United States human population is about ten times that of Canada. Production of meats in the United States is likewise approximately ten times greater. Live cattle and beef can move relatively freely between the two countries according to price differentials in the markets. As price spread becomes large enough to compensate for transportation, tariff and currency exchange costs, live cattle and beef may move from the lower to the higher priced market. As a result, the United States has a strong influence on Canadian live cattle and beef markets.

The supply-demand balance

For many years Canada was traditionally a net exporter of beef but it became a net importer in 1969. The largest Canadian export is cow beef sold to the United States, the largest beef importer in the world. Quality beef, mainly in the form of finished live cattle, is imported by eastern provinces from the United States in varying volumes, depending on the Canada-U.S. price differential. At the same time, in the later 1980s surplus live finished cattle have been exported to the western U.S. market from Alberta. The bulk of

Canada's beef imports are manufacturing grade beef from Australia and New Zealand.

Alberta beef production in the future

There are too many variables involved to allow long-term projections of beef production and beef requirements to be made with confidence. Many factors will have a bearing on what unfolds in the future.

- Interest rates will have a strong influence on whether or not some producers are able to stay in the business. They may also affect the decisions of people contemplating entering the beef industry.
- The rate of inflation will strongly influence future production through its effect on input costs and consumer demand.
- World demand for grain as food will have a bearing on what grains farmers produce and hence on the kind, volume and cost of grain available for cattle feeding.
- If the grain transportation system is improved to the point of being able to carry all the grain for which there is an export market, the effect on cattle production will be different from the situation where grain for export continues to move at present levels.
- The decisions of governments with regard to marketing boards, guaranteed minimum returns on specific commodities, special interest rates to farmers, feed grain policy, feed grain pricing and freight rates will have a bearing on future beef production.
- Various provincial subsidy programs to livestock and feed grain producers may distort the natural advantages of producers in different parts of the country and influence where beef production will be most profitable.
- Red meat stabilization programs could help remove some of the risk associated with the price fluctuations of the beef cycle.

Canada will continue to be a beef consuming nation, but there will not be a quick return to the 45.4 to 49.9 kg (100 to 110 lb) per capita consumption of the mid-1970s. Once market share is lost it takes time to win it back. Consumption is more likely to be somewhere between 38.6 and 43.1 kg (85 and 95 lb) per capita for the rest of this decade. Increases in the disappearance of dressed beef beyond the 1980s will be mainly related to population growth unless a much greater development of export markets occurs. Alberta should continue to play the dominant role in Canada's beef industry.

Beef cow-calf production costs

Introduction

Overall production costs in a cow-calf operation show broad year-to-year and region-to-region fluctuations. High interest rates, feed and fuel costs resulted in significant increases through the early 1980s. By 1987 a world surplus of feed grains resulted in major reductions in production cost.

For many years most of the cost fluctuation was caused by winter feed costs. In recent years interest on borrowed capital has become a worrisome source of high and fluctuating cost. For purposes of examination and discussion, costs of production are divided into two categories:
(a) overall costs excluding winter feed
(b) winter feed costs.

The estimated production costs that follow are based on an assumed management program under which cattle are pastured for six months and fed a wintering ration for six months.

No two farms or ranches have exactly the same production costs; however, there are similarities in costs within a geographic area. A 1986 survey of beef farms across Alberta has been used as a guide in arriving at cost figures in table 2. The table provides figures for various cost items involved in present day cattle production. A blank column is provided as part of the table for the use of producers who have sufficiently detailed records to allow them to insert their own cost figures. Some of the costs may have to be adjusted for individual situations.

Table 2
Production costs per cow

	Survey Cost	Your Cost
A. CASH COSTS:		
Equipment - fuel and repairs	17.95	
Miscellaneous tools and equipment	0.76	
Fence/building repairs	10.25	
Operating interest paid	4.97	
Utilities	9.72	
Accounting and legal costs	3.30	
Hired labour	9.03	
Livestock purchases (calves)	4.96	
Veterinarian and medicine costs	11.46	
Custom work hired	9.79	
Transportation and marketing	5.76	
Bedding and supplies	13.79	
Miscellaneous	2.88	
Taxes and insurance	3.46	
Purchased feed	32.61	
* Home grown feed (farm value-cash cost)	91.39	
Total cash costs (farm value)	232.07	
B. CAPITAL COSTS AND UNPAID LABOR:		
Depreciation - buildings and equipment	32.84	
Interest paid on capital loans	13.51	
* Home grown feed (farm value - capital cost)	66.06	
Operator and family labor	68.94	
Total capital and unpaid labor costs (farm value)	181.35	
C. TOTAL PRODUCTION COSTS		
Based on farm cost of feed production	413.45	

* These are the producer's actual costs when using home grown feed
SOURCE: *Production and Resource Economics Branch Alberta Agriculture 1988.*

Winter feed costs

Winter feed costs fluctuate from year to year depending on the cost of feed stuffs. Winter feed costs have been developed using three different types of rations. They include feeding at a maintenance level for early winter and at higher levels for late pregnancy, postcalving and until cows go to summer pasture. These rations were calculated at National Research Council recommendations for average milking 500 kg (1100 lb) cows with adjustments for Alberta conditions.

Although these rations make some allowance for cold weather, in very cold conditions additional feed will be required to meet the cow's needs for energy. For every 10°C that the midday temperature is below -20°C an additional 3 kg (6.6 lb) of hay, 6.2 kg (13.7 lb) of silage or 2 kg (4.4 lb) of grain should be fed, depending on which type of ration is used. If there were 30 days each winter that averaged -30°C as a midday temperature, the winter feed cost would be 4 to 6 per cent higher than those given in the following tables.

Winter feed costs for first calf heifers can be taken from these tables also, since the feed requirements for growing heifers are approximately the same as the requirements for mature cows.

Table 3
Winter Feed Costs per Cow Using a Hay Ration

(Costs based on 10 kg (22 lb) brome hay for 75 days, 11.3 kg (25 lb) brome hay for 45 days and 11.3 kg (25 lb) alfalfa-brome hay for 60 days)

Cost of Alfalfa-brome hay			Cost of brome hay								
		¢/kg	2.2	3.3	4.4	5.5	6.6	7.7	8.8	9.9	11.0
¢/kg	¢/lb	¢/lb	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
2.2	1.0		43	57	71	84	98	112	126	140	154
3.3	1.5		50	64	78	91	105	119	133	147	161
4.4	2.0		58	72	86	99	113	127	141	155	169
5.5	2.5		65	79	93	106	120	134	148	162	176
6.6	3.0		73	87	101	114	128	142	156	170	184
7.7	3.5		80	94	108	121	135	149	163	177	191
8.8	4.0		88	102	116	129	143	157	171	185	199
9.9	4.5		95	109	123	136	150	164	178	192	206
11.0	5.0		103	117	131	144	158	172	186	200	214
12.1	5.5		110	124	138	151	165	179	193	207	221
13.2	6.0		118	132	146	159	173	187	201	215	229

Example: If brome hay costs 6.6¢/kg (3¢/lb) and alfalfa-brome hay costs 7.7¢/kg (3.5¢/lb), the feed cost to winter a 500 kg (1100 lb) cow would be $135.00.

Table 4
Winter Feed Costs per Cow Using a Straw and Grain Ration

(Costs based on 5.4 kg (12 lb) straw and 2.7 kg (6 lb) grain for 75 days, 5.9 kg (13 lb) straw and 4.1 kg (9 lb) grain for 45 days, and 6.4 kg (14 lb) straw and 5.0 kg (11 lb) grain for 60 days)

Cost of Grain			Cost of Straw								
		¢/kg	1.1	1.7	2.2	2.8	3.3	3.9	4.4	5.0	5.5
¢/kg	¢/lb	¢/lb	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
4.4	2.0		$ 42	48	54	59	65	71	77	83	88
5.5	2.5		50	55	61	67	73	79	84	90	96
6.6	3.0		57	63	69	75	80	86	92	98	104
7.7	3.5		65	70	76	82	88	94	100	105	111
8.8	4.0		72	78	84	90	95	101	107	113	119
9.9	4.5		80	86	91	97	103	109	115	120	126
11.0	5.0		87	93	99	105	111	116	122	128	134
12.1	5.5		95	101	107	112	118	124	130	136	141
13.2	6.0		103	108	114	120	126	132	137	143	149
14.3	6.5		110	116	122	128	133	139	145	151	157
15.4	7.0		118	123	129	135	141	147	153	158	164

Example: If straw costs 3.3¢/kg (1.5¢/lb) and grain costs 11.0¢/kg (5¢/lb) the feed cost to winter a 500 kg (1100 lb) cow would be $111.00.

Table 5
Winter Feed Costs per Cow Based on Cereal Silage and Grain

(Costs based on 16.3 kg (36 lb) silage (as-fed, 65% moisture) and 2.3 kg (5 lb) grain for 75 days, 19.1 kg (42 lb) silage and 2.3 kg (5 lb) grain for 45 days, and 19.1 kg (42 lb) silage and 3.2 kg (7 lb) grain for 60 days)

Cost of Grain		Cost of Silage (as-fed, 65% moisture)								
		¢/kg	.55	1.1	1.65	2.2	2.8	3.3	3.9	4.4	5.0
¢/kg	¢/lb	¢/lb	.25	.50	.75	1.00	1.25	1.50	1.75	2.00	2.25
4.4	2.0		$ 38	56	74	92	109	127	145	163	180
5.5	2.5		43	61	79	97	114	132	150	168	185
6.6	3.0		48	66	84	102	119	137	155	173	191
7.7	3.5		53	71	89	107	125	142	160	178	196
8.8	4.0		59	76	94	112	130	147	165	183	201
9.9	4.5		64	81	99	117	135	153	170	188	206
11.0	5.0		69	87	104	122	140	158	175	193	211
12.1	5.5		74	92	109	127	145	163	181	198	216
13.2	6.0		79	97	115	132	150	168	186	203	221
14.3	6.5		84	102	120	137	155	173	191	209	226
15.4	7.0		89	107	125	143	160	178	196	214	231

Example: If silage costs 3.3¢/kg (1.5¢/lb) and grain costs 8.8¢/kg (4¢/lb) the winter feed cost for a 500 kg (1100 lb) cow would be $147.00.

Above-average management can effect an improvement in percent calf crop weaned and an increase in weaning weights.

The following tables illustrate:

1. How percent calf crop weaned and weaned weight combine to translate into kilograms (or pounds) of calf produced per cow. (tabel 6)
2. How the break-even selling price (i.e. the price required to recover production costs) is lowered as weight of calf per cow wintered increases. (tables 7, 8)
3. How an improvement in percent calf crop weaned is magnified in terms of dollar returns per cow by high average weaned weight and by substantial prices for feeder calves. (tables 9, 10)

Table 6
Kilograms (or pounds) of Calf Produced per Cow at Various Weaning Weights and Percentage Calf Crop Weaned.

		Weaned Weight								
% Calf	kg	136	159	181	204	227	249	272	295	318
Crop	lb	300	350	400	450	500	550	600	650	700
Weaned										
100		136	159	181	204	227	249	272	295	318
		300	350	400	450	500	550	600	650	700
95		129	151	172	194	215	237	259	280	302
		285	333	380	428	475	523	570	618	665
90		122	143	163	184	204	225	245	265	286
		270	315	360	405	450	495	540	585	630
85		116	135	154	174	193	212	231	251	270
		255	298	340	383	425	468	510	553	595
80		109	127	145	163	181	200	218	236	254
		240	280	320	360	400	440	480	520	560
75		102	119	136	153	170	187	204	221	238
		225	263	300	338	375	413	450	488	525
70		95	111	127	143	159	175	191	206	222
		210	245	280	315	350	385	420	455	490
65		88	103	118	133	147	162	177	192	206
		195	228	260	293	325	358	390	423	455
60		82	95	109	122	136	150	163	177	191
		180	210	240	270	300	330	360	390	420
55		75	86	100	112	125	137	150	162	175
		165	193	220	248	275	303	330	358	385
50		68	79	91	102	113	125	136	147	159
		150	175	200	225	250	275	300	325	350
45		61	72	82	92	102	112	122	133	143
		135	158	180	203	225	248	270	293	315
40		54	64	73	82	91	100	109	118	127
		120	140	160	180	200	220	240	260	280

Source: Marketing Division and Animal Industry Division, Alberta Agriculture.

Table 7
Break-Even Selling Price per Kilogram for Calves

Kilograms of Calf Per Cow Wintered	Production Costs per Cow Wintered								
	300	350	400	450	500	550	600	650	700
113	2.65	3.10	3.54	3.98	4.42	4.87	5.31	5.75	6.19
125	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60
136	2.21	2.57	2.94	3.31	3.68	4.04	4.41	4.78	5.15
147	2.04	2.38	2.72	3.06	3.40	3.74	4.08	4.42	4.76
159	1.89	2.20	2.52	2.83	3.14	3.46	3.77	4.09	4.40
170	1.76	2.06	2.35	2.65	2.94	3.24	3.53	3.82	4.12
181	1.66	1.93	2.21	2.49	2.76	3.04	3.31	3.59	3.87
193	1.55	1.81	2.07	2.33	2.59	2.85	3.11	3.37	3.63
204	1.47	1.72	1.96	2.21	2.45	2.70	2.94	3.17	3.43
215	1.40	1.63	1.86	2.09	2.33	2.56	2.79	3.02	3.26
227	1.32	1.54	1.76	1.98	2.20	2.42	2.64	2.86	3.08
238	1.26	1.47	1.68	1.89	2.10	2.31	2.52	2.73	2.94
249	1.20	1.41	1.61	1.81	2.01	2.21	2.41	2.61	2.81
261	1.15	1.34	1.53	1.72	1.92	2.11	2.30	2.49	2.68
272	1.10	1.29	1.47	1.65	1.84	2.02	2.21	2.39	2.57

Source: Animal Industry Division, Alberta Agriculture.

Example: If production costs are $500 per cow wintered and 204 kilograms of calf are produced per cow wintered, the break-even selling price for the calves would be $2.45 per kg.

Table 8
Break-Even Selling Price per Pound for Calves

Pounds of Calf per Cow Wintered	Production Costs per Cow Wintered								
	300	350	400	450	500	550	600	650	700
250	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80
275	1.09	1.27	1.45	1.64	1.82	2.00	2.18	2.36	2.54
300	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33
325	.93	1.08	1.23	1.38	1.54	1.69	1.85	2.00	2.15
350	.86	1.00	1.14	1.29	1.43	1.57	1.71	1.86	2.00
375	.80	.93	1.07	1.20	1.33	1.47	1.60	1.73	1.87
400	.75	.88	1.00	1.13	1.25	1.38	1.50	1.63	1.75
425	.71	.82	.94	1.06	1.18	1.29	1.41	1.53	1.65
450	.67	.78	.89	1.00	1.11	1.22	1.33	1.44	1.56
475	.63	.74	.84	.96	1.05	1.16	1.26	1.37	1.47
500	.60	.70	.80	.90	1.00	1.10	1.20	1.30	1.40
525	.57	.67	.76	.86	.95	1.05	1.14	1.27	1.33
550	.55	.64	.73	.82	.91	1.00	1.09	1.18	1.27
575	.52	.61	.70	.78	.87	.96	1.04	1.13	1.22
600	.50	.58	.67	.75	.83	.92	1.00	1.08	1.17

Source: Animal Industry Division, Alberta Agriculture.

Example: If production costs are $500 per cow wintered and 450 pounds of calf are produced per cow wintered, the break-even selling price for the calves would be $1.11 per pound.

Table 9
Increase in Gross Returns per Cow from a 5% Increase in Calf Crop Weaned at Given Weaning Weights and Calf Prices*

Calf Prices ¢ per kg	Average Weaned Weight of Calves (kg) 113	136	159	181	204	227	249	272
1 10	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00
1 21	6.87	8.25	9.62	11.00	12.37	13.75	15.17	16.50
1 32	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00
1 43	8.13	9.75	11.38	13.00	14.63	16.25	17.88	19.50
1 54	8.75	10.50	12.25	14.00	15.75	17.50	19.25	21.00
1 65	9.38	11.25	13.13	15.00	16.88	18.75	20.63	22.50
1 76	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
1 87	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50
1 98	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00
2 09	11.86	14.25	16.63	19.00	21.38	23.75	26.13	28.50
2 20	12.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00
2 31	13.13	15.75	18.38	21.00	23.63	26.25	28.88	31.50
2 43	13.75	16.50	19.25	22.00	24.75	27.50	30.25	33.00
2 54	14.38	17.25	20.13	23.00	25.88	28.75	31.63	34.50
2 65	15.00	18.00	21.00	24.00	27.00	30.00	33.00	36.00
2 76	15.63	18.75	21.88	25.00	28.13	31.25	34.38	37.50
2 87	16.25	19.50	22.75	26.00	29.25	32.50	35.75	39.00

Source: Marketing Division and Animal Industry Division, Alberta Agriculture.

* Increase in gross return per cow in dollars.

Example: At a price of $2.20 per kg and a weaning weight of 181 kg, a 5% increase in calf weaning percentage would increase gross returns per cow by $20.00.

Table 10
Increase in Gross Returns per Cow from a 5% Increase in Calf Crop Weaned at Given Weaning Weights and Calf Prices*

Calf Prices in ¢ per lb	Average Weaned Weight of Calves (lb) 250	300	350	400	450	500	550	600
50	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00
55	6.87	8.25	9.62	11.00	12.37	13.75	15.17	16.50
60	7.50	9.00	10.50	12.00	13.50	15.00	16.50	18.00
65	8.13	9.75	11.38	13.00	14.63	16.25	17.88	19.50
70	8.75	10.50	12.25	14.00	15.75	17.50	19.25	21.00
75	9.38	11.25	13.13	15.00	16.88	18.75	20.63	22.50
80	10.00	12.00	14.00	16.00	18.00	20.00	22.00	24.00
85	10.63	12.75	14.88	17.00	19.13	21.25	23.38	25.50
90	11.25	13.50	15.75	18.00	20.25	22.50	24.75	27.00
95	11.86	14.25	16.63	19.00	21.38	23.75	26.13	28.50
1 00	12.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00
1 05	13.13	15.75	18.38	21.00	23.63	26.25	28.88	31.50
1 10	13.75	16.50	19.25	22.00	24.75	27.50	30.25	33.00
1 15	14.38	17.25	20.13	23.00	25.88	28.75	31.63	34.50
1 20	15.00	18.00	21.00	24.00	27.00	30.00	33.00	36.00
1 25	15.63	18.75	21.88	25.00	28.13	31.25	34.38	37.50
1 30	16.25	19.50	22.75	26.00	29.25	32.50	35.75	39.00

Source: Marketing Division and Animal Industry Division, Alberta Agriculture.

* Increase in gross return per cow in dollars.

Example: At a price of 80¢ per pound and a weaning weight of 400 pounds, a 5% increase in calf weaning percentage would increase gross returns per cow by $16.00.

Management of the Beef Herd

Brood cow management

Introduction

One of the most important aspects of a beef herd operation is reproduction. Even though a cow may have the potential to produce a heavy calf at weaning time, she will be a failure if she does not have a calf. The importance of reproduction is sometimes minimized and only receives a passing thought when the herd sire is turned out with the breeding herd and is expected to get all cows in calf.

Producing a healthy live calf from each cow in the herd every 12 months is impossible to achieve without the very best reproductive management. Inadequate levels of nutrition and poor reproductive management of the breeding herd can result in a drastically reduced calf crop.

We must have a method of measuring reproductive efficiency before discussing and evaluating the reproductive management of the beef herd. Per cent calf crop is generally used to express breeding or reproductive efficiency and is calculated by dividing the total number of calves born by the number of cows bred. The average calf crop in Alberta is below 85 per cent. This is a sign that reproductive efficiency is an important economic problem in the province.

Per cent calf crop does not give the total economic picture of the breeding herd. Terms such as the percentage of calves weaned or weight of calf weaned per cow bred provide a much better measurement of efficent production.

While a herd can be very productive in terms of individual weaning weights, herd productivity may be very low when the percentage of calves weaned per cow bred is considered.

Table 11
Effect of per cent calf crop on average weight of calf weaned per cow bred

	Average weaned weight of calf per cow bred				
% Calf Crop	lb	lb	lb	lb	lb
100	400	450	500	550	600
90	360	405	450	495	540
80	320	360	400	440	480
70	280	315	350	385	420

As an example, (table 11), if the average weaning weight of a herd were 550 lb but the calf crop was only 80 per cent, the average weaning weight per cow bred would only be 440 lb.

In herds where AI is practised, the term "services per conception" is a good measure of an individual cow's fertility. On a herd basis, conception rate, expressed as a percentage (number of cows conceived as a percentage of those bred) is a good measure of reproductive efficiency. The term "nonreturn rate" is often used, but it should not be confused with conception rate. The nonreturn rate is the percentage of the cows bred which did not return for a second service. The nonreturn rate will generally be up to 10 per cent greater than the actual conception rate.

Body condition and reproduction

Introduction

Body condition is a measure of the amount of body fat that an animal is carrying. It is one *management indicator* that can be used to predict herd fertility and to determine feeding programs. Producers should become aware of the condition scoring system. There are four points to consider:

- how to condition score
- the relationship between body condition score and post-calving fertility
- feeding strategies in relationship to condition score
- practical application of condition scoring.

Condition scoring beef cattle

Body condition scoring is a subjective "hands on" method of determining the amount of fat an animal is carrying. The advantage of a condition score measurement is that it is easy to learn. It is fast, simple and cheap. Condition scoring does not require specialized equipment, but it is sufficiently accurate for many research and management situations. The simple condition score has many management implications. It allows everyone to speak the same language when describing body condition. Condition scoring assigns a numerical rating based on the feel of a cow rather than ambiguous rating terms based on a visual appraisal such as "fat", "moderate" or "thin".

What is body condition scoring?

Body condition is scored from 1 (very thin) to 5 (grossly fat). The fat cover over the loin area between the hip (hook) bone and the last rib is the major location on the animal's body for condition scoring, especially in thin animals. It is measured by placing the hand on the loin area, fingers pointing to the opposite hip bone. With the thumb, feel the fat cover over the ends of the short ribs (see figure 1). The short ribs are also termed spinous processes in some reports.

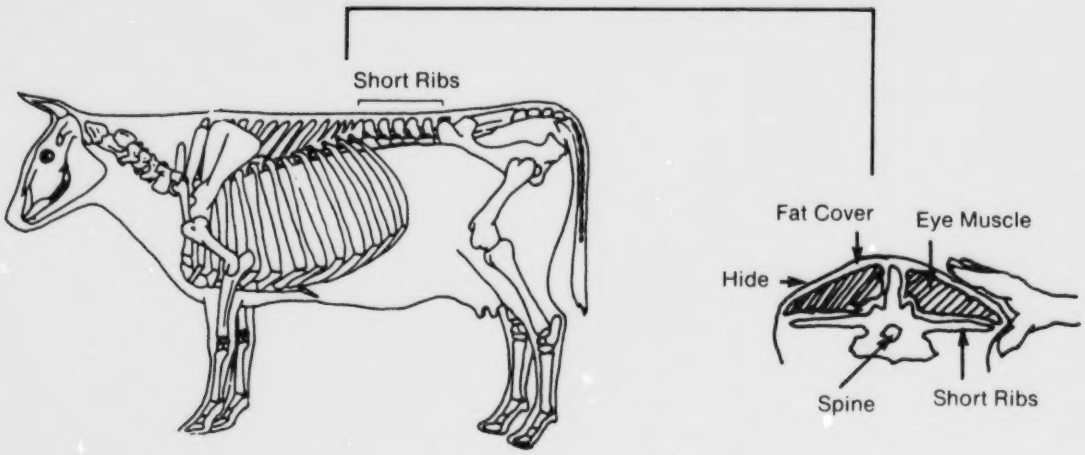


Figure 1 - Where to condition score

Because there is no muscle between the end of the short ribs and the skin, any padding felt by the thumb will be fat. In cows that score above a 3, the short ribs can no longer be felt, even with firm pressure; therefore, in fatter cattle, the fat cover around the tail head and over the ribs is also used to assess the animal's condition score.

The condition scoring system

The system uses the following descriptions to define each score:

Score 1: The individual short ribs are fairly sharp to the touch and there is no fat around the tail head. The hip bones, tail head and ribs are visually prominent.

Score 2: The short ribs can be identified individually when touched but feel rounded rather than sharp. There is some tissue cover around the tail head and over the hip bones and the flank. Individual ribs are no longer obvious.

Score 3: The short ribs can only be felt with firm pressure. The areas on either side of the tail head now have a degree of fat cover, which can be easily felt.

Score 4: Fat cover around the tail head is evident as slight "rounds" that are soft to the touch. The short ribs cannot be felt even with firm pressure, and folds of fat are beginning to develop over the ribs and thighs of the animal.

Score 5: The bone structure is no longer noticeable and the animal has a "blocky" appearance. The tail head and hip bones are almost completely buried in fat and folds of fat are apparent over the ribs and thighs. The short ribs are completely covered by fat and the animal's mobility is impaired by the large amounts of fat.

In practice, an animal's condition may fall between the above values in which case intermediate numbers (halves) can be used. For example, a 2.5 score indicates the animal is intermediate between a 2 and a 3 for body condition. It is important to remember that condition scores cannot be measured visually because a full hair coat can hide a very poor condition. A condition score must be measured by feeling for fat cover.

When to condition score

Cows should be condition scored three times in each production year as follows:

- Fall pregnancy check/start of winter feeding program - Optimum score is 3.0.
- At calving - Optimum score for mature cows is 2.5; optimum score for first-calf heifers is 3.0.
- Thirty days before the start of the breeding season - Optimum score is 2.5 for all females.

Relationship between condition score and post-calving fertility

Adequate nutrition before and after calving is essential for optimum reproductive performance. Feeding programs that result in thin cows at calving or in a loss of body condition after calving increase the interval from calving to estrus (standing heat) and decrease first service conception rates. An increase in days to estrus or a decrease in conception rate will result in fewer cows becoming pregnant in the first three weeks of the breeding season.

The information presented in table 12 shows that cows with a score of 2.0 or less took longer to return to normal estrus than cows that scored 2.5 or greater. Cows with a score of 2.0 or less at calving had a lower pregnancy rate in the first part of the breeding season regardless of the feeding program after calving. In addition, the study indicated that post-calving feeding programs did not appear to affect the potential fertility of cows scoring 2.5 or better at calving. Flushing cows by feeding a

very high level of energy just before and during the breeding season appeared to increase the number of thin cows (scoring 2.0 or less at calving) becoming pregnant in the first three weeks of the breeding season.

Table 12
Effect of body condition at calving on subsequent reproduction

Cow condition score at calving	postpartum nutrition	Days to show heat	Pregnant in first 20 days of breeding (%)
2.0 or less	Low	56	30**
	Low + flushing	67	45
	Moderate or high	60	43
MEAN		59*	41**
2.5 or greater	Low	50	55
	Low + flushing	49	55
	Moderate or high	48	50
MEAN		49	52

Source: Adapted from Richards et al., 1986. J. Anim. Sci. 62:300
*Significantly different than cows calving in a body condition score of 2.5 or greater.
**Significantly lower than any other group.

The information presented in table 13 shows that under group-feeding conditions only about 64 per cent of the cows fed below-maintenance requirements actually lost body condition. In contrast, 40 per cent of the cows fed to maintain body condition were unable to maintain body condition, and 33 per cent of the cows fed at a high plane of nutrition were unable to do so. Overall, there was a modest decrease in the number of days from calving to estrus when cows were fed at or above maintenance requirements. However, the marked decrease in the number of days to estrus was observed only in cows that were able to maintain body condition, regardless of the calculated level of nutrition.

Table 13
Effect of loss on maintenance of body condition in cows fed different diets

Dietary group[a]	Lost condition after calving	Average days to estrus
Fed 90% of requirement	63.6%	58
Fed 100% of requirement	40.0%	40
Fed 110% of requirement	33.3%	35
All cows that lost condition		60
All cows that maintained condition		32

Source: Adapted from Rutter and Randel, 1984. J. Anim. Sci. 58:265

[a]Percentage of calculated NRC requirements for metabolizable energy; all diets were equal in crude protein, mineral and vitamin supplementation. Dietary groups contained 11, 10 and 9 animals for the 90%, 100% and 110% treatments, respectively.

To obtain optimum post calving fertility, mature cows should calve in a body condition score of 2.5 to 3.0 and be able to maintain that condition through the breeding season. Flushing, the practice of feeding a very high level of energy for a couple of weeks before the start of the breeding season, only works in cows that are below optimum condition and can gain condition to reach an optimum score (2.5) during flushing. Flushing will not enhance reproduction in cows (typically scoring 1.5 or less) that are unable to gain enough condition during flushing. Cows that are in a body condition score of 2.0 about 30 days before the start of the breeding season may be helped to rebreed by the use of flushing and by the use of a controlled suckling treatment. Controlled suckling involves removing a calf for 48-hours or limiting nursing to once daily until the cow is in heat.

Another adverse effect of inadequate cow nutrition is the reduction in pounds of calf weaned. Reports indicate a 5 per cent to 25 per cent reduction in adjusted 205-day weaning weight of calves from dams with a body condition of less than 2.0 at calving and from suckled cows losing condition after calving. The amount of weight loss in the current year depends on breed type and severity of underfeeding before cows go to good pasture. If the cow herd has access to good or excellent pasture within 45 to 60 days of when most calves are born the weaned weight of the current calf crop may not be reduced as much as indicated above.

The major loss in pounds of calf weaned occurs in the following year. Pounds of calf weaned are reduced the following year among undernourished cows because calf weaning weight is markedly affected by age of the calf at weaning. If one assumes that an average calf will gain about 2 pounds per day from birth to weaning, then for every estrous cycle that a cow remains open, the calf is 20 days younger and about 40 pounds lighter at weaning. The information in table 14 shows the next-year's estimated relative losses, in terms of weight of calf weaned, based on various management decisions made before and after calving this year.

If a cow is fed to lose one-half of a body condition score over the winter, there will be a savings in winter feed costs. In contrast, feed costs will be 20 to 30 per cent higher for cows fed to gain one-half of a body condition score over the winter compared with those fed to maintain body condition. Cows that calve with a body condition score of 2.0 or less will usually show a decrease of weaned calf-weight the next year, regardless of the nutritional level offered after calving. This loss results from cows either failing to become pregnant or conceiving later in the breeding season. When cows calve with a body condition score of 2.5 and lose condition after calving, there will be a reduction in next year's calf weaning weight. The reduction is caused by an average two to five week delay in the return to estrus after calving. Cows that have a 2.5 condition score when they calve and are able to at least maintain that condition after calving are the most successful in both rebreeding on time and optimizing pounds of calf weaned.

Condition scoring and feeding strategies

From a nutritional viewpoint, fat represents the storage of energy in a body. Cows can accumulate body fat during periods of surplus energy intake, building up a reserve of energy that can be drawn upon in times of need. The term "feeding off her back" refers to the use of previously accumulated body fat.

The accumulation of fat in beef cattle is not an efficient process. The efficiency of retaining digestible energy (DE) in the form of body tissue varies from about 30 per cent for dry cows fed low quality diets to about 60 per cent for suckled cows fed high quality diets. To *improve one unit* of body condition score requires about 1900 Mcal of DE. This is the equivalent of over 1200 pounds of barley grain or almost 1 ton of average quality hay. *Each unit loss* of body condition score will supply the equivalent of 900 Mcal of DE. This is equal to 600 pounds of barley or 900 pounds of hay.

How can body condition be manipulated to reduce feeding costs? It is a common practice to put lactating cows on good quality feed, usually pasture, for 6 to 8 months after calving. In addition to stimulating milk production, considerable weight gain is usually achieved, especially in late lactation. Many mature cows gain in excess of 200 pounds (the equivalent of one unit of body condition score) during the pasture season. A reasonable target for body condition at fall weaning is 3.0. If this condition is not achieved by the end of the summer grazing season, producers should consider weaning calves early so that the cows have at least one month of good fall grazing in which to gain condition before winter feeding begins.

Cows entering the winter with a condition score of 3.0 have several advantages over cows scoring less than 2.0. The extra fat tissue provides some internal insulation against heat loss. It also provides an energy reserve that can be called upon when the amount of daily feed is insufficient to meet the cow's needs. In other words, the daily feed allowance offered to cows in good condition can be limited to reduce wintering costs of the cow herd. An 1100 pound cow scoring 2.5 needs to maintain her body weight and condition over the winter as well as to provide for the nutrition of the growing fetus. She requires about 20 to 22 pounds of hay per day to do this. However, a 1200 pound cow scoring 3.0 can afford to contribute about one-half pound of body tissue "off her back" each day, reducing the amount of feed required. She needs about 18 to 20 pounds of hay per day, a saving of 10 per cent. The pounds of hay specified

Table 14
Effect of body condition on this year's feed cost and next year's calf weaning weight

Pre-calving management	Winter feed cost* (% of maintenance)	Cow Condition at calving	After calving management	Weeks delay in conception (80 day exposure)	Loss in next year's calf weaning weight
Lose condition (from 2.5 to 2.0)	85-90%	2.0	Lose condition (from 2.0 to 1.5 or less)	10	up to 70% loss
Maintain condition at 2.0	100%	2.0	Maintain condition at 2.0	8	up to 40% loss
Gain condition (from 1.5 to 2.0)	120-130%	2.0	Gain condition (from 2.0 to 2.5)	5	up to 15% loss
Lose condition (from 3.0 to 2.5)	85%	2.5	Lose condition (from 2.5 to 2.0)	2	5% loss
Maintain condition	100%	2.5	Maintain	0**	0% loss
Gain condition (from 2.0 to 2.5)	Gain condition 120-130%	2.5	condition (from 2.5 to 3.0)	0**	0% loss

* Winter feed cost relative to maintenance can only be calculated if the amount of condition gained or lost is known. Losing 0.5 lb/head/day of body tissue would result in a loss of 0.5 units of condition score in 200 days and would reduce feed cost by 10-15%. To gain 0.5 units requires twice as much energy. Note: These figures do not include weight change caused by fetal growth.

** Conceived in the first 21 days of breeding.

here represent actual intake. The feed waste factor, present in all feeding systems, will increase the amount of hay that must be offered to reach these levels of intake.

Sometimes, cows enter the winter in thin condition (score less than 2.0) and need to gain considerable weight before calving. A cow that has to improve one unit in condition (gain approximately 200 pounds) must be fed about 7 pounds of barley or 11 pounds of hay above what she requires for maintenance. This increases the feed cost of wintering the cow by approximately 50 per cent.

Cows that calve with a condition of less than 2.5 need to gain weight rapidly. If an improvement of one-half unit of condition score (100 pounds) is required in the first 60 days after calving, a high quality ration must be fed. Approximately 10 pounds of barley per day will be required above what the cow needs for normal maintenance and milk production. This often coincides with the "mud season" which makes grain feeding difficult for many cow-calf producers. Under most conditions it is impossible to feed cows that score less than 2.0 well enough between calving and breeding to have a positive effect on fertility.

Condition scoring can be used to sort a cow herd into groups that have similar nutritional needs. Both bred heifers and thin cows need more energy than mature cows that score 2.5 to 3.0, and will benefit from reduced competition for feed as well.

The ideal feeding program is one that recognizes the ability of the beef cow to safely and economically gain and lose body condition. Managers should be aware that it costs over twice as much to improve body condition as it does to use excess body condition to supplement the daily energy intake.

Improve body condition when dietary energy is least expensive (usually in the summer). Let the cow lose condition when dietary energy is expensive (usually in the winter). Managers should recognize that a rapid loss in condition is not safe and that a rapid increase in condition is not always possible. And while condition scoring is a useful tool for evaluating the energy status of a cow, it is not useful in determining if she has received an adequate amount of the other important nutrients such as protein, vitamins and minerals.

Practical application of condition scoring

Learn how to condition score

- The producer need not remember all 5 condition scores. The most useful score to remember and to shoot for is the score of 2.5.
- Condition scoring is more accurate than "eyeballing". Keep records of condition scores.
- Cows should be scored in the fall, at calving and 30 days before the start of the breeding season.
- If condition scoring the cow herd at calving and before the start of the breeding season is not feasible, a producer could use an alternative twice per year strategy: once in the fall and once after calving (30 to 45 days before the start of the breeding season).

- Although condition scoring the cow herd between calving and the start of the breeding season may be inconvenient, breeding problems caused by inadequate nutrition are most likely to be detected during this critical time.
- A record can be kept of an individual animal's condition score. Alternatively, a representative group of cows from very large herds can be scored to give an estimation of average herd condition score.

Use condition scores as management indicators

Thin cows (cow scoring 2.0 or less)

- Look for causative factors:
  - lack of sufficient feed,
  - excessive competition at the feed bunk,
  - internal/external parasites,
  - disease or injury.
- Be aware of problems that may be encountered:
  - increased calving difficulty (scores of 1.5 or less),
  - increased calf death loss,
  - delayed breeding or open cows,
  - fewer pounds of calf weaned.
- Make corrective management decisions:
  - feed young and thin cows separately from mature cows in adequate condition,
  - improve winter diet (NOTE: Do not rely on "flushing" thin cows to increase reproductive rates),
  - control parasites,
  - vaccinate against common diseases,
  - wean calves about one month earlier in the fall.

Fat cows (score 3.5 or greater)

- Look for causative factors:
  - did not wean a calf,
  - produced very little milk,
  - overfeeding or overabundant feed.
- Be aware of problems that may be encountered:
  - increased calving difficulties (scores of 4.0 or greater),
  - decreased calf vigor and (or) survival,
  - lower fertility,
  - low weaning weights,
  - feed costs too high.
- Make corrective management decisions:
  - cull nonfertile or subfertile cows and cows that do not produce a growthy calf,
  - do not over feed cows already in adequate body condition (score of 2.5); feed separately if necessary,
  - let cows coming off pasture in a body condition score of 3.0 or better lose some condition over the winter.

It is important to realize that inadequate cow nutrition not only affects current calf weaning weight as a result of poor milk production but also affects next year's calf weaning weight owing to a delay in days to conception. The full effect of a breeding problem in the current year is not realized until about one and one-half years later.

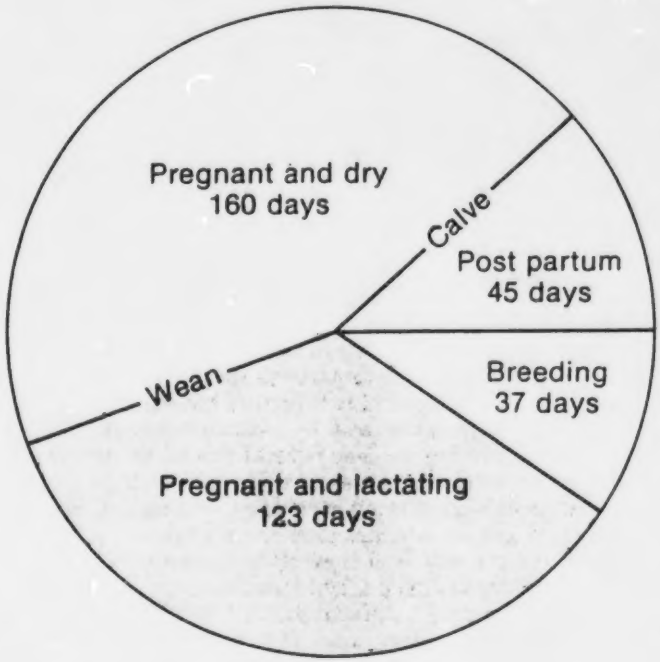


Figure 2 - Cow reproductive calendar

Rebreeding

The beef cow has an extremely difficult task in weaning a calf each year and calving early again the next season. The gestation length in beef cows can range from 270 to 300 days; the average is 283-285 days. First-calf heifers tend to have shorter gestations than mature cows. The exotic breeds tend to have a slightly longer gestation period than the British breeds.

Because the cow is pregnant 282-285 days of the year, there are only 80 days for the cow to be rebred if she is to maintain a yearly calving interval. This is a short period of time considering the cow must recover from the stress of calving and feed her calf while her reproductive tract is returning to its normal size and position (involution) in preparation for the next pregnancy. The time for complete involution is between 30 and 45 days after calving, while it is generally 45 to 60 days before a cow will show her first estrus. The interval from calving to first estrus can vary widely and can be affected by the age of the cow, the level of nutrition, calving difficulties and uterine infection.

Table 15 gives an indication of the effect age and time have on the return of cows to heat following calving.

Table 15
Percent cows in heat
at varying intervals following calving

Age of cow	Days after calving						
	40	50	60	70	80	90	100
	Per cent						
5 years or older	55	70	80	90	90	95	100
2-3 years	15	30	40	65	80	80	90

Source: Wiltbank, 1969

Only 15 per cent of the 2 and 3 year olds and 55 per cent of the older cows exhibited estrus 40 days following calving. This age related difference was maintained until 80 days post calving when the younger cows began to catch up. The slower return of younger females to full fertility helps explain why second calf heifers have a lowered percentage of calf crop or have calves born later in the calving season. Several factors contribute to the delay in first-calf heifers exhibiting estrus after calving. Young cows have an extra drain on their system because they are still growing while nursing a calf, and they often cannot compete for supplemental feed when running with older cows.

By breeding virgin heifers 20 to 30 days prior to the main breeding herd, first calvers will have extra time to resume their estrus cycle and conceive during the early part of the next breeding season.

If a cow does not conceive during her first heat period in the breeding season, it will be another 20 days before she cycles again. Because each heat cycle that a cow misses this year delays her calf approximately 20 days next year and because a calf gains about 0.9 kg (2 lb) per day from birth to weaning, each heat cycle that is missed will mean about 18.1 kg (40 lb) less calf at weaning next year.

First-calf crossbred heifers from breeds with high milk production will often require supplemental feed to achieve an adequate "flushing" before the breeding season. Without this flushing, researchers have found that high milking heifers fail to conceive and produce a calf in their second calving season.

The delay in cows showing estrus is also accompanied by a low level of fertility as shown by the conception rates in table 16.

Table 16
Conception rate at first
service after parturition

Days postpartum	Per cent first service Conception
0- 30	33
31- 60	58
61- 90	69
91-120	74

Other research has indicated that conception rates before 60 days postpartum and after 120 days are low. Many of the cows that fail to conceive within 120 days are problem breeders and will often be open at the end of the breeding season.

The following factors are closely related to good reproductive efficiency in the beef herd and should be considered for obtaining or maintaining a highly productive herd.

Shorten the calving season

Calves from early-calving cows will be heavier and more uniform at weaning. Cows calving late in the calving season have will wean lighter calves and are more likely to have a poor conception rate because there is less time for their reproductive system to prepare for rebreeding. If the breeding season is prolonged, individual cows in the herd will lose several days each year until eventually one year they will miss getting rebred.

The best way to prevent an extended calving season of 90 to 120 days or more is to make sure that the cows and replacement heifers are properly prepared for the breeding season. Feeding the cows and first calf heifers to ensure they have the right condition score at calving will help to reduce the number of difficult births and will ensure that cows and first calf heifers start their heat cycles as soon as possible after calving. The nutrition of the breeding herd after calving is equally important to maintain a body condition that will allow satisfactory first service conception rates. An early return to heat cycles and high first service conception rates are necessary to shorten the calving season and maintain a shortened calving season from year to year.

In may cases (especially when replacement heifers from heavier milking strains are used) it may be necessary to feed the first calf heifers separately with extra feed to allow them to maintain the proper condition for rebreeding.

A breeding soundness evaluation should be conducted on all bulls before the start of the breeding season. Bulls should also be observed carefully through the breeding season to ensure they are continuing to service and settle the cows in calf without delay.

Once the management of the breeding herd is properly planned and supervised, as many as 70 per cent or more of the cows and heifers should conceive in the first heat cycle after the start of the breeding season. With that type of fertility 97 per cent to 100 per cent of the cows can be expected to conceive by the end of a 63 day breeding season. Under very high levels of management some beef herds in Alberta have achieved nearly 100 per cent conception in a 45 day (2 heat cycle) breeding season.

Once high levels of fertility have been established in both cows and bulls through attention to nutrition and health, fertility levels can be

maintained by limiting the breeding season to 45 - 60 days and culling the few cows who will be open in the fall.

Herd managers who attempt to shorten the calving season by restricting the breeding season without first providing for the other essential management factors run the risk of having to cull a high percentage of their late calving cows in the first year. This can have a very serious impact on the weaned calf crop and cash flow in the next year.

Other aids can be used to help shorten the breeding season. One of the most successful aids has been prostaglandins, which when injected into normally cycling cows will allow them to come into heat in 2-3 days and permit breeding by AI or bull. However, prostaglandins and hormones should not be used as a substitute for good management. These drugs can best be used under good management with cows that are making weight gains prior to the breeding season and are close to estrus or are showing initial signs of estrus.

Short term calf removal, where calves are removed from their dams for 48 hours at 45-50 days after calving, has been beneficial in stimulating estrus on an experimental basis (table 17).

Table 17
Short term calf removal and pregnancy

	After 21 Days of breeding	
	Heat (%)	Pregnant (%)
Control	31	17
Calf removal for 48 hours	62	44

Source: Adapted from Wiltbank, 1978

Once-daily suckling and early calf weaning have also been beneficial in getting cows rebred in a shorter period of time. However, producers should be aware that results from early weaning, once-daily suckling and short-term calf removal are still preliminary. Conditions in individual herds may vary. In some cases these practices may not be feasible. The costs of supplying the necessary handling facilities and extra labor may be more than the extra returns from more calves born early in the calving season.

Effect of nutrition on reproductive efficiency

Inadequate nutrition can affect reproductive efficiency particularly in getting a cow bred again after calving. Nutrition of the cow both before and after calving is important if the cow is to exhibit estrus and conceive early in the breeding season. Figure 3 shows the changes in the energy requirement of a cow during the various stages of the reproductive cycle.

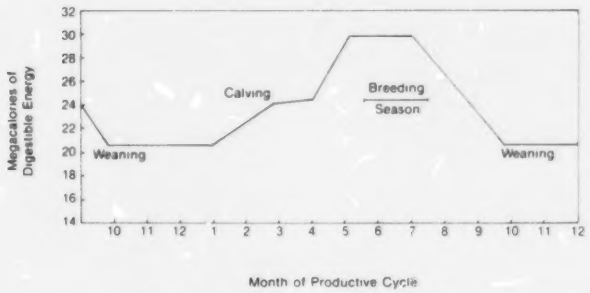


Figure 3 - Energy requirement for a 544 kg (1200 lb) beef cow by stage of production

The nutritional requirement for energy increases by 60 per cent and the protein requirement doubles during the early part of the breeding season in comparison to the dry period.

Further evidence of the importance of good nutrition, as demonstrated by the condition of cows at calving, is presented in table 18. At 80 days after calving only 62 per cent of the thin cows and 88 per cent of the cows in moderately good condition exhibited estrus. Most of the cows in thin condition would be unable to maintain the 12 month calving interval that is necessary for a profitable beef operation.

Table 18
Effect of body condition on percentage of cows showing heat at various periods after calving

		Days After Calving					
		40	50	60	70	80	90
Body Condition at Calving	No. of Cows	Percent in Heat					
Thin	272	19	34	46	55	62	66
Moderate	364	21	45	61	79	88	91
Good	50	31	42	91	96	98	100

Source: Wiltbank (1978)

Culling

Proper culling of the beef herd after the breeding season will improve reproductive performance. All breeding females should be pregnancy tested by a veterinarian at or following weaning. Generally, all open cows and heifers should be culled. In addition, pregnant breeding females should be visually examined for soundness. Those with conditions such as lumpjaw, cancer eye, mastitis, poorly attached udders, poor feet and legs and reproductive problems should be culled. Often these will be older cows that are approaching the end of their productive lives. Culling non-pregnant and poor health risk cows will directly

improve calf crop percentages and keep health-related losses in the herd to a minimum. A final additional cull should be made on the basis of performance test records. Cows that produced low indexing calves at weaning should be culled because a low weaning index is indicative of poor milking ability or poor genetic quality. The severity of culling will depend on the individual value of the breeding females as well as the total number of cows the producer wishes to retain in his herd.

Culled animals should be sold for slaughter so that another producer does not purchase a problem animal. Calves from cows culled for physical defects or low performance should not be selected as breeding stock.

Recent research at the University of Alberta and at Arizona State University shows the value of cull cows can be increased at a reasonable cost if they are properly fed for four to eight weeks before slaughter. The Arizona research showed that in the first five weeks on feed, thin culled cows gained as much as 2.5 kg (5.5 lb) (empty body weight) per day with feed consumption of less than 2.7 kg (6 lb) for each .45 kg (1 lb) of gain. The University of Alberta reported in the 1979 Feeders Day Bulletin that feeding cull cows for 63 days improved the dressing percentage and the grade. This was reflected in an improvement in both the price per pound and the total value of the cows when sold.

The Arizona study showed that cows began to deposit more fat and the gains became more costly after 35 to 42 days on a high concentrate ration. The profit from feeding cull cows will be influenced by the price of feed, the original condition of the cows, and the price spread between thin cows and cows with improved grades, due to more finish.

Evaluation of the performance of the herd should be done at weaning time because the production cycle is completed. Producers should calculate various herd performance indices to judge the efficiency of various management techniques and to predict possible future problems. There is no better way to obtain these indicies — condition scores, percent calf crop, calving frequency, weaning weights, record of animals treated and cost per pound of calf marketed — than to maintain accurate herd records and analysis for key productive indicators.

Beef cattle performance testing

The beef cattle performance testing program (ROP) is a computerized record keeping system designed to assist the manager to evaluate production of the herd. It also provides an analysis of individual animals to assist in the selection of replacements or culling of poor producers.

Fertility and growth rate are the two traits most emphasized in ROP programs. Fertility is assessed by calculating calving interval. New techniques are now being developed to estimate in which cycle conception occurs. Growth is determined by evaluating average gain over specific time periods (usually 200-day weaning weight and yearling weight). Selection for these two traits plus culling for undesirable traits encourages improvement in total herd performance.

New versions of the ROP program tend to emphasize total herd performance. The success or failure of breeding or management decisions is best evaluated by looking at the total effect on herd productivity. These new ROP programs provide useful information with which to evaluate the effects of breed, dam age, fertility level and breeding season as well as other things.

It becomes immediately apparent that more detailed analysis requires more information. However, producers who prefer a simple analysis need not shun the program because the new versions of ROP are designed to accept many levels of input and will do all that is possible with whatever is submitted. Producers desiring more answers must submit more information. The ROP program is very flexible.

In earlier programs certain basic data were required before the ROP program could function. This is no longer the case. To get specific answers certain groups of data must be collected and are therefore mandatory for that specific program. If data are missing, the computer simply skips that particular analysis and does what it can with the rest.

Basic data

The basic "data set" required for most analyses would include the following:

- breeding season
- cow and calf identification
- cow and calf age (i.e., birth dates)
- weaning weight and sex of calf.

Optional data

By adding breed of sire and dam, ID of sire, pregnancy check results, date of service, calving ease, calf condition at birth and reason for calf death losses and by grouping cows into breeding and management groups, much additional information can be included in the analysis. Provision is made in some ROP programs to include other producer-specific data sets. These data will simply be listed and recorded on cow histories, but not analyzed.

Interpretation of results

Calving interval - The calving interval is a good measure of fertility. If one or a few cows have a long interval, it indicates a problem with them. If several cows have long intervals it indicates

either a management problem or the use of subfertile sires.

Calving interval is considered to have a low heritability. You cannot really affect calving interval by selecting for it. However, it responds directly to management. If high producing cows are the ones with long intervals, they are probably not receiving sufficient feed to meet their high level of production. By culling long-interval cows, you remove cows that habitually calve late and raise light unprofitable calves.

A new method of evaluating fertility is to determine in which estrous cycle conception occurred. Highly fertile cows that respond adequately to herd management should conceive in the first or second cycle after the bulls are introduced. Major or persistent variations from this indicate a problem.

Calving percentage - The next item requiring close observation is calving percentage. Ideally every cow bred and not culled should have a calf. Calves should be born early in the season in order to have enough time to grow to a large size by weaning time. If the calf crop slips much below 85 per cent, some area of management needs to be improved.

Weaning weight - This trait is considered heritable. At 30 per cent it is only moderately heritable, indicating that weaning weight can be influenced in a major way by nongenetic factors (e.g., pasture condition).

Weaning weight reflects, to a large degree, the milking and mothering ability of the calf's dam. By selecting for weaned weight, the growth potential of the calf will be raised and the milk production of selected female replacements will rise.

Weaning weight is a good method with which to evaluate dam performance. Actual weaned weight is preferable to an adjusted 200 day weight. It is important to recognize the effect that late calving has on productivity of the cow. The better ROP programs do evaluate the cow on the actual weaning weight of her calf. Poor producing cows are easy to spot in these programs.

Average weaning weight can be used in many ways to evaluate herd management or breeding decisions. One can compare the production of sires, pasture types, breeds and cross-breeding programs and then take action on the basis of these comparisons, to correct or avoid management problems.

Use of records for selection

Other traits are listed in the ROP report and can be used in selection program. The important concept to grasp is that producers must discover their problem areas. They must then decide if it is practical or potentially profitable to correct the deficiency. ROP records and analysis only point out the results of present practices. The decision whether or not to modify production practices must still be made by the producer.

The ROP program also does not say definitely which calves should be selected as replacements or which cows should be culled. It only ranks the animals in the order they perform for the trait being observed. Whether or not the highest ranking calf should be retained may depend on other traits that have significant influence such as temperament, structural soundness, proper sexual development and size. A live calf is more valuable than a dead or missing one; therefore, it might be unwise to cull cows that have small calves at weaning if the alternative is to keep cows who do not regularly raise a calf to weaning.

The ROP program can be a valuable aid to a manager in evaluating the production records of the herd. All producers should keep some records of their herd. Not everyone will benefit from major ROP programs, but all do benefit from keeping track of production of the unit and the results of changes in herd management. ROP is an attempt to help improve profitability of the herd, not just its rate of growth.

How to enroll - The simplest way is to contact a local district agriculturist or the beef cattle specialist at the nearest regional office of Alberta Agriculture. They will have the necessary forms with which to enroll. Breeders should not overlook ROP programs offered by their breed associations. Some of these programs are excellent, while others are rather simple. You might benefit from looking at a sample of the various options offered by different agencies.

Cold weather management strategy

Naturally occurring cold stress does not often present a serious problem of survival for mature beef cattle. Mature cows, bulls and replacement cattle on wintering diets will, however, require additional feed to produce the heat needed to maintain body temperature during periods of extreme cold (tables 4 and 5). The ability of cattle to resist cold stress is determined by the amount of heat produced and the amount of heat insulation provided by the hair coat, hide and subcutaneous fat tissue. If an animal does not receive enough feed to produce the heat required, it will draw on its own tissue reserves. The result could be lower vigor of the calf or its mother and poor breeding performance the following year. A thin cow is more susceptible to any future cold stress.

Research at the University of Alberta has shown that once wintering beef cattle are conditioned to cold weather, they will remain comfortable in still air temperatures from -10°C to -20°C. Below these temperatures, cattle will seek extra shelter, more bedding, or they will increase their normal appetite to supply extra heat energy. It was shown that thin cows were more sensitive to cold stress than fat cows, but because they were

lighter, they required 26 per cent less feed for normal maintenance over the winter. This is a considerable saving, but it must be balanced against the possibility of less disease resistance and more risk of breeding failure.

During periods of cold weather the ration for thin cows had to be increased by 10 to 30 per cent to meet their energy requirements. Nutritionists in Alberta now suggest that the winter maintenance energy requirements for beef cows should be increased as much as 10 to 15 per cent over the National Research Council recommendations (see nutrition section of this manual).

Summary

An understanding of the reproductive cycle and the management necessary for the maintenance of reproductive efficiency is necessary for a profitable beef operation. Shortening the breeding season, pregnancy testing and culling open cows, developing well-grown replacements and providing adequate nutrition for production and reproduction are essential in maintaining reproductive efficiency. The goal of every beef cow operation should be the production of a live healthy calf from each cow in the herd at a yearly interval.

Calving time

"The basis of a healthy calf is a healthy pregnancy"

Pregnancy and nutrition

The nutrition of the cow during pregnancy has an important effect on the incidence of dystocia or calving difficulty, calf survival and the subsequent fertility of the cow. Proper nutrients in sufficient quantity must be provided for the maintenance of the cow and the growth of her unborn calf. Depending on the breed of the cow and her body condition when weaning her previous calf, the cow should gain between 100 and 200 lb before her next calving date. Heifers and thin cows require special attention because they are going through a period of growth themselves, which requires a higher level of nutrition. Consequently, they should be fed in groups separate from the main herd.

However, it is possible to overfeed the pregnant animal resulting in overfatness at calving time. This should be avoided and cows should calve with a body condition score of 3.

Stages of labor

Stage I - Relaxation

The pelvic girdle through which the calf must pass at the time of birth is normally a firm, bony ring. Just prior to parturition (calving), the joints and ligaments associated with the pelvic girdle become more elastic and allow both the vertical and horizontal diameters to increase, facilitating passage of the calf. The relaxation of the ligaments around the tail is a sign commonly used to identify cows that are preparing to deliver a calf.

Also, the external opening into the birth canal (vulva) becomes swollen and discharges a clear mucous material. The udder becomes noticeably enlarged. The animal will experience discomfort, be restless, separate from the herd, look or kick at its flank, and continually lie down.

Just prior to calving, the muscles of the uterus contract rhythmically, with the time between periods of contraction becoming progressively shorter. These uterine contractions are involuntary, that is, the cow is unable to control them because they are brought on by the secretion of hormones. The contractions of the uterus force the calf, which is surrounded by fluids and fetal membranes, towards the cervix or neck of the womb. Meanwhile, the cervix itself is undergoing relaxation and the pressure of the contracting uterus forces some of the membranes (waterbag) through the opening. Once a portion of the fetus protrudes through the cervix into the vagina, reflex stimuli result in voluntary pushing or straining by the strong abdominal muscles and the first stage of labor ends.

Stage II - Active labor

As the calf enters the birth canal, the involuntary contractions of the uterus are now strongly reinforced by contractions of the powerful abdominal muscles. These combined contractions, plus the movements of the calf, mould the calf to the shape of the birth canal and it is expelled through the vulva. Most animals will lie down as soon as straining commences. The time required to complete the second stage of labor is from 0.5 to 1 hour in a cow to 3 hours for a first calf heifer.

Stage III - Involution

After the calf has been delivered, the uterus continues to have contractions for several days. The placenta (afterbirth) is usually expelled within 6 hours after the calf is born, but the lochia (uterine fluids) continue to be discharged from the vulva in variable amounts for up to 2 weeks after calving. Complete involution of the uterus takes between 30 to 40 days after an uncomplicated calving but may take a longer period of time following a dystocia or retained placenta.

Calving Problems

Some problems in Stage I

Uterine inertia or loss of activity of the uterus or calf bed will cause the cow to show some of the early signs of labor, but she will fail to commence actively attempting to deliver her calf. This may be caused by any of a number of factors including

poor nutrition, overcondition, and the presence of another disease (e.g., mastitis).

In cases of uterine inertia, professional assistance should be sought.

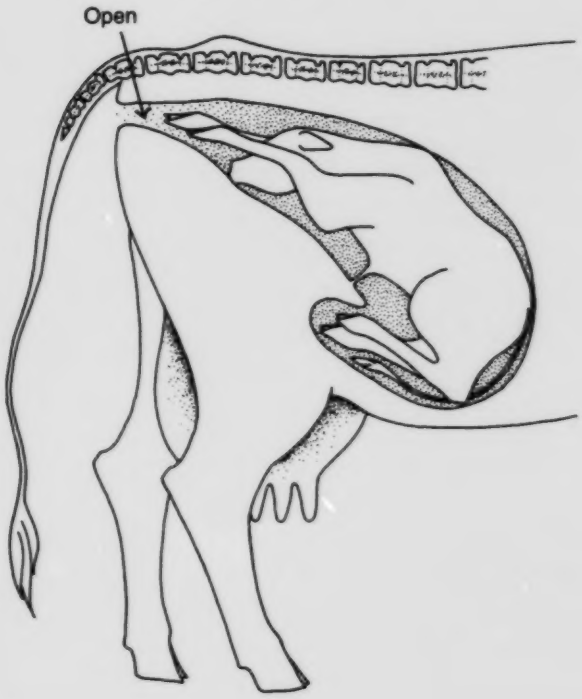


Figure 4 - Normal Position Prior to Birth

Nondilation of the cervix causes signs similar to those described for uterine inertia, in that, the cow usually does not go into active labor. During pregnancy, the cervix is about the size of an orange and has a very narrow undulating passage through the centre. At the time of parturition, the canal enlarges, partly through the actions of hormones, to allow the passage of the calf.

Again, a veterinarian should be consulted because attempts to physically force the passage of the calf may result in irreparable or fatal damage to the dam.

Some Problems Seen in Stage II

Dystocias (difficult birth) are of two types. Maternal dystocias result from abnormalities of the dam, some of which are caused by:

- immaturity - the size of the pelvis canal is too small
- pelvic abnormalities, e.g., fractures, deformations, abscesses
- uterine inertia (as in Stage I) usually brought on by fatigue
- uterine torsion - the uterus has rotated resulting in twisting of the vagina (figure 5).

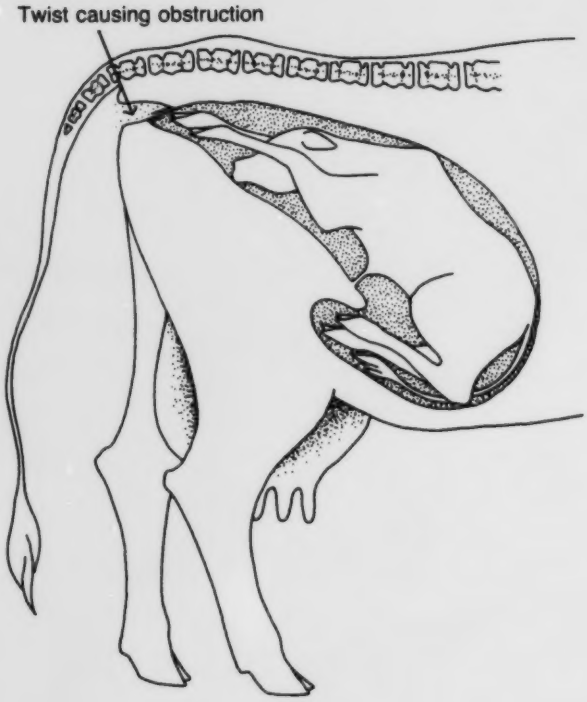


Figure 5 - Uterine Torsion

Fetal dystocias result from abnormalities caused by the calf, examples of which are:

- excessive size of calf
- monster or abnormally formed calf
- abnormal positioning of the calf (figure 6)
- multiple births (figure 7).

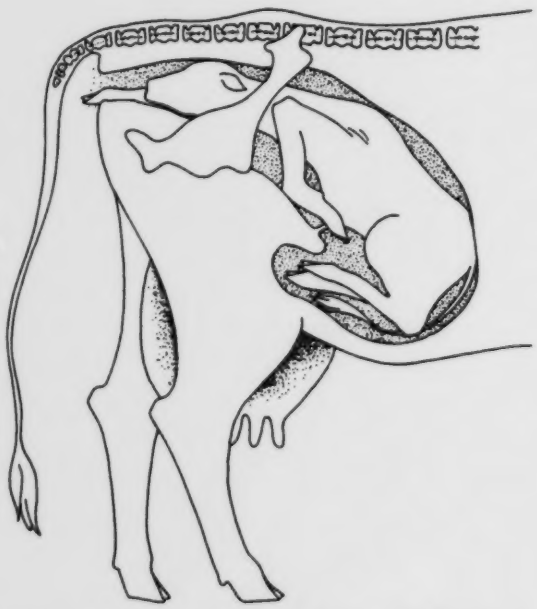


Figure 6 - Dystocia caused by postural defects

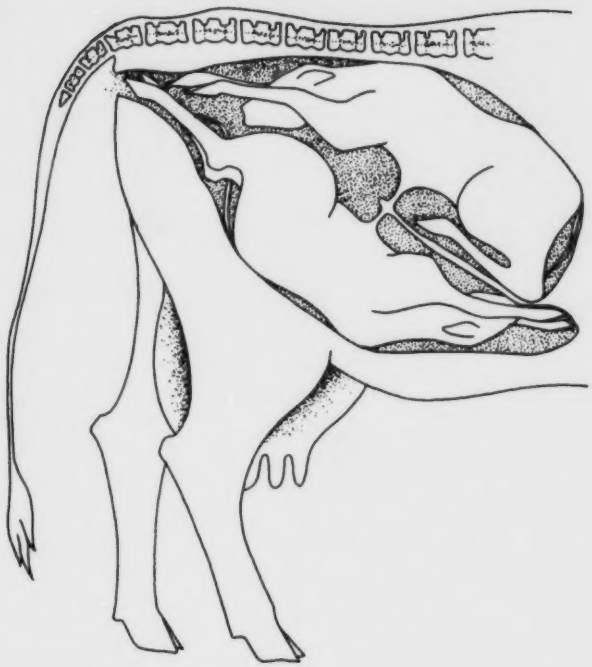


Figure 7 - Dystocia caused by twins

Assistance with dystocia

There are six important rules to bear in mind in handling a cow with a calving problem:

Know when to intervene - if intervention is too early, especially in the case of a first calf heifer, damage may be inflicted to the dam when trying to remove the calf too soon. On the other hand, if intervention is delayed too long, the chance of delivering a lively calf will be greatly reduced. As a rule of thumb, if a heifer has been actively pushing for more than an hour and is not making any progress, intervention may be necessary. In the case of a cow, one half-hour of active labor should be resulting in progress towards delivering the calf.

Be clean - use clean chains or calving straps that have been boiled and kept handy in a polythene bag. Wash the cow's external genitalia and your arms with soap and water to which a mild disinfectant has been added. If the cows defecates while you are trying to deliver the calf, stop and clean up again, so as to minimize the contamination of the cow's uterus.

Be gentle - although force is sometimes needed to extract the calf, and considerable strength and stamina may be needed to correct a displacement, the power used has to be directed with intelligent understanding of what is happening. The art of delivering a calf lies in the ability that permits one to mould the shape of the calf and vagina in such a manner that will most advantageously allow the calf to slide through the pelvic canal. A combination of judiciously used power and intelligent feeling for the shapes and contours can result in a gentle delivery.

Don't pull unless there are three things in the birth canal - There must always be three parts of the calf in the birth canal. If the calf is being delivered head first, there must be two front feet as well as the calf's nose in the birth canal. If the calf is being delivered backwards, there must be two hind feet as well as the calf's tail entering the birth canal. An absence of one of these three parts is an indication of an abnormally positioned calf and will prevent its delivery. Traction at this point may make correction of the problem more difficult as well as increase the risk for survival of both the cow and calf.

Know your limitations - This is difficult advice to follow because the greater one's experience is, the easier it is to recognize the limitations of any particular method of delivering a calf. In most adult cows, the very difficult deliveries will involve extremely large or abnormal calves, multiple births, uterine twists or a large rotten calf. The risk of damage to the cow will be minimized if the operator has acquired the experience to handle difficult births. In each of these cases, the problems are usually associated with the amount of space inside the mother relative to the calf. Again, experience can allow the operator to decide whether a caesarian will prevent damage to the mother or loss of the calf.

Limit the time that you work on an animal - If distinct progress is not obvious within 10 or 20 minutes, call your veterinarian. Loss of time means loss of lubricating fluid, swelling of the vagina, and less space to work, exhaustion of the cow, reduced viability in the calf and increased difficulty in correcting the problem.

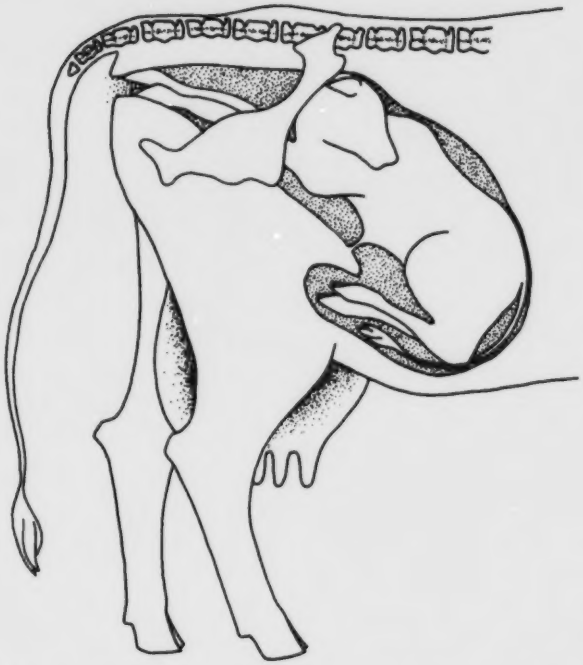


Figure 8 - Dystocia caused by lateral deviation of the head.

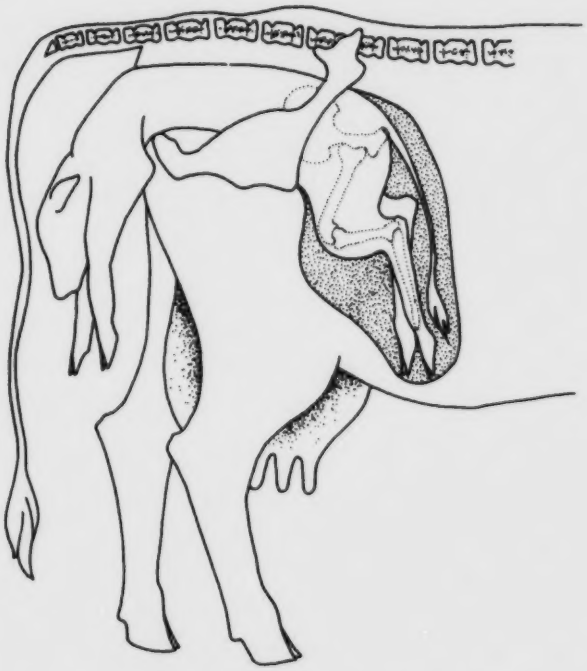


Figure 9 - Dystocia caused by a hiplock

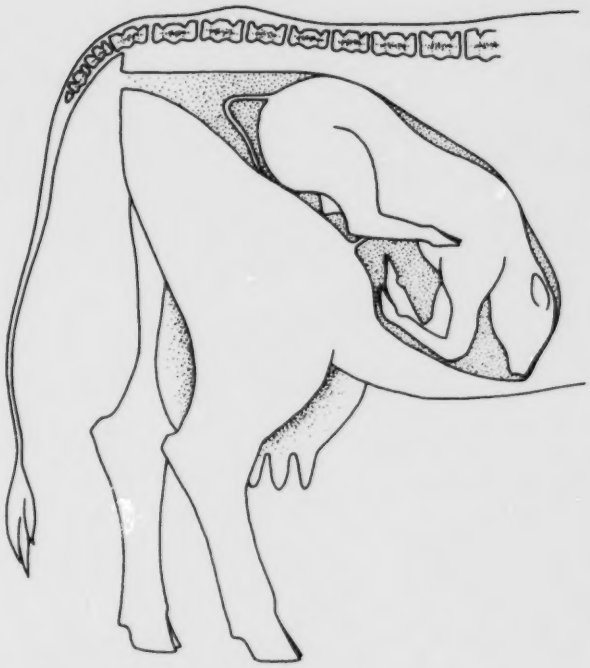


Figure 10 - Breech presentation

Hints on calving a cow

(1) Have a clean, well bedded area in which to work.

(2) Examine the situation and if the nose and two feet are in the birth canal, you can do one of two things; allow the animal more time to make some progress on her own or give some assistance especially in the case of heifers if the cervix and the vagina are fully dilated.

(3) If you decide to help the animal, get ready first. Assemble your helpers, ropes, chains, lubricants, hot water and disinfectant. Tie the cow's head securely because there is no time to be lost in handling the cow once an intervention begun.

(4) Normally, a calf will be delivered head first. The head must ALWAYS be dealt with first. If the head is back, it must be brought fully into the pelvis. If necessary, a thin rope may be placed around the head (behind the ears) and the loop drawn snugly into the mouth. With the head secured, the limbs may be dealt with. The feet may best be lifted into the pelvis by placing the little hooves in the cup of one's hand. This prevents points from tearing the wall of the uterus.

(5) Sudden traction should be avoided. The calf's elbows may jam on the brim of the cow's pelvis, therefore they must be eased out one at a time. Pulling first on one leg and then the other copies the calf's normal birth movement and reduces the width of its body. Pulling two legs at the same time greatly increases the diameter of the calf.

If the cow's passage is getting dry, lubricate the calf's coat with lard. Common cooking lard will stick to the coat longer than the more expensive jellies and greases that can be purchased as "obstetrical lubricants."

If the calf becomes stuck at the hips (hiplock), it is best first to introduce some grease (lard) around the hips. Then try to twist the calf on its side. The assistants should commence pulling as the operator presses gently up and down on the calf's middle (figure 9).

Calf pullers are often used, but all too often they are used unskillfully and the calf or cow is damaged. True, a calf puller can delivery a calf, but power is not a replacement for skill, care and gentleness.

(6) The legs will indicate when the calf is coming backwards. A front leg can be easily differentiated from a hindleg - the front leg has two joints, the knee and the fetlock (ankle) between the foot and the elbow; in the case of the hindleg, there is only one joint between the foot and the hock (figure 10).

Care must be taken so that the tail of the calf does not turn back over the thigh because if it does it may tear the roof of the vagina. As with the forelimbs, traction must first be applied to one limb, then the other. If this is not done, and an attempt is made to draw the two hips through the pelvis at the same time, the diameter of the calf will be greatly increased.

(7) The foregoing hints cover the simplest needs of the producer. Attempts to deal with more complex situations are strongly discouraged, and the producer is advised to recognize as early as possible when professional aid is needed.

After-calving problems

Vaginal tears or lacerations are commonly seen after calving, especially in heifers. Usually no special treatment is required unless the tears become infected. In such cases, intramuscular injections of antibiotics may be needed. Deep lacerations require the attention of a veterinarian soon after they have occurred.

Uterine tears require the immediate attention of a veterinarian since the cow will be in grave danger. They may be detected by doing a vaginal exam after calving.

A prolapsed uterus occurs when a cow continues to push after calving and eventually forces the calf bed through the vulva insideout so it hangs out behind her down to her hocks. This is an emergency situation to which a veterinarian should be called immediately. Until the uterus can be replaced, it should be wrapped, it possible, in sheets kept moistened with a warm disinfectant solution. It is imperative to keep the cow quiet and leave her alone, if necessary, to prevent further injury to the uterus.

If a cow continues to force after the calf is born, a uterine prolapse may be prevented by forcing the animal to stand and move around.

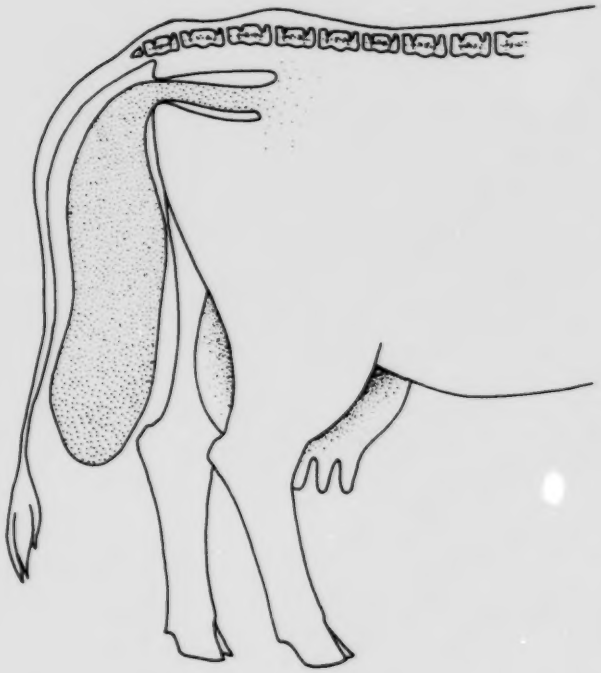


Figure 11 - uterine prolapse.

Obturator paralysis is a condition where a cow, or more commonly a heifer, is unable to get up on her hind legs after calving. Delivery of an exceptionally large calf or using excessive traction during delivery may cause damage to the nerves to the hind legs of the cow where they pass through the bones of the pelvis.

There is no specific treatment for obturator paralysis and it should not be confused with milk fever (low blood calcium). Rest in a well-bedded stall and periodically rolling the cow from side to side to prevent bed sores are helpful to prevent further damage to the hind legs from occurring.

It is wise to consult a veterinarian about any cow that fails to get up shortly after calving.

Retained placenta can occur following a normal birth, when the uterus fails to expel all of the fetal membranes (placenta) within 12 hours after delivery of the calf.

There are many causes of a retained placenta including dystocia, twinning, abortion or premature birth and nutritional deficiencies. If the incidence of retained placenta exceeds 8 or 10 per cent of the calving cows, a veterinarian should be consulted to determine the cause.

Do not attempt to peel the fetal membranes off the caruncles of the uterus because a high risk of hemorrhage or infection may occur, resulting in reduced fertility in the following breeding period. The placenta is best left alone or simply cut off

where it hangs out of the vulva. This prevents the uterus from acting as a wick, allowing infection to travel up into the cow's uterus. Sometimes antibiotics are placed in the uterus to control the infection. However, this is also likely to result in a delay in the decomposition of the placenta, and therefore delay its passage.

If an animal with a retained placenta loses her appetite or seems dull and lethargic, she may have an elevated temperature. Injections of an antibiotic should be given daily until the problem clears up. A veterinarian should do a postpartum examination of the uterus of this cow within a month after calving to make sure that the uterus is involuting normally and all infection is clearing up.

Management of the calf

Care of the newborn calf

Resuscitation is aimed at establishing proper functioning of respiration and blood circulation. If the calf fails to breathe within 10-15 seconds after birth, it should be grasped by the hind limbs, lifted from the ground with the head hanging down and swung back and forth between two people for several moments so that the mucous is expelled from the lungs and trachea. Avoid prolonged hanging or swinging as it may result in the stomach contents being emptied out the esophagus; if the calf gasps, the contents can be inhaled into the lungs. Wipe the nostrils and mouth clear of mucous. Vigorously massaging the chest wall as well as allowing the cow to lick the calf are usually helpful.

A gentle flow of oxygen may be required or, if necessary, mouth-to-mouth resuscitation can be applied, but be sure to use only shallow respiration because excessive inflation may rupture the calf's lungs. If there is evidence that the heart has stopped, a sharp slap on the calf's chest over the heart may help.

Dip the calf's navel thoroughly as soon after birth as possible. Keep a wide-mouthed jar of 2.5 per cent iodine solution handy to the calving pen.

Colostrum of good quality and in sufficient amounts is very important for the health of the calf. If vigorous nursing has not started within 2 - 3 hours of birth, colostrum should be given to the calf at the rate of 5-6 per cent of its body weight using a bottle and nipple or an esophageal feeder. Calves born after a dystocia often do not nurse for up to 12 hours, and it is important to administer colostrum to these calves as soon after birth as possible and make sure that the calf is nursing normally by 12 hours after birth.

Calving to weaning

The period of time from birth to weaning includes many procedures that cause stress. Some of the major ones in addition to actually weaning the calf are dehorning, branding, castrating and vaccinating. A calf will tolerate almost any stressful procedure better while it is still on the cow than after it has been weaned.

If possible avoid performing several procedures on the calf at one time. Dehorn as soon after birth as it is practical. Availability of time and labor usually dictate that branding, castrating and vaccinating are done at one time. Where possible, the cows and calves should be given a few days to "mother-up" and rest before they are moved any great distance if these three operations were performed at one time.

Calf identification

This is necessary for performance testing, pedigree, and proof of ownership. There are several methods available.

Ear tagging has become a popular method of identifying calves for record keeping and performance testing. Ear tags should be large enough for the numbers to be visible several yards from the animal. This allows identification of the calf without having to confine or restrain it. However, some ear tag losses are inevitable with large plastic tags. To assure permanent identification, the calf can be tagged with a small metal tag in addition to the large plastic tag. Tattoos on purebred or recorded animals provide permanent identification. Ear tagging should be done immediately after birth. Clean and disinfect ear tagging equipment after each use on a calf.

Tattooing is required for all registered and recorded cattle identification under the Canadian Livestock Pedigree Act. Tattooing should be done shortly after birth unless calves are individually identified in some other manner such as ear tagging. When tattooing, take care to ensure that the letters are securely fastened in the head of the pliers. Test the numbers and letters for proper sequence by applying the pliers to a piece of cardboard. Make sure that the calf's ear is properly cleaned, that the tattoo is properly positioned and applied, and that the tattoo ink is well rubbed in. Never use ink that has been frozen. Tattoo equipment should be cleaned and disinfected between usuage on calves.

Branding is not compulsory but has many advantages. In Alberta a properly recorded brand is evidence under the law that an animal carrying that brand is owned by the registered owner of the brand. It is unlawful to use an unregistered brand or a brand for which registration has expired. A brand should be applied in such a manner that it is visible under all conditions, is readable under most conditions and is definitely readable when it is clipped. The size of the iron is very important. Each character should be not less than 10 cm high and 7.5 cm wide, outside measurements, for calves under one year. An iron 15 cm high and 9 cm wide is recommended for grown cattle.

The hot iron method of branding is still the most efficient. If an iron is at the correct degree of heat, the application should take only 3 to 5 seconds on calves. The job can be done quickly by pressing firmly and rocking the iron slightly to vary the pressure and obtain uniform application of the entire character. At completion, the hide should be the color of buckskin or new saddle leather. Burning too lightly will make only a temporary brand. Holding the iron on too long causes unnecessary pain and excessive burning which may result in a wound which is difficult to heal. A botched brand resulting from too much heat is difficult to read.

Vaccination

The proper vaccination program for calves will vary somewhat from area to area. Your local veterinarian should be consulted to assist in the development of a vaccination program in conjunction with a sound herd health program. The veterinarian will be able to make recommendations for those diseases which are occurring in each area and take into account any unique requirements an individual herd may have. Here are some general guidelines for a vaccination program for calves in Alberta.

All calves should be vaccinated for the clostridial diseases (blackleg and malignant edema) at branding time. The best age to vaccinate calves for blackleg is two to three months; however, it is frequently necessary to vaccinate calves at a younger age, before they are turned out to pasture. All calves should be given a booster near weaning time.

Calves develop a much greater level of immunity if they are vaccinated when they are not undergoing stress. Because of this, calves should be vaccinated about three weeks prior to weaning for infectious bovine rhinotracheitis (IBR). Give the booster vaccine for blackleg at this time also. If the cow herd has not been vaccinated for IBR, consult a veterinarian before IBR vaccine is given to the calves if the calves are to be turned back out with the cows.

About two to three weeks after weaning, all replacement heifer calves should be vaccinated for bovine virus diarrhea (BVD). Consult with your veterinarian on the type of vaccine to use and the necessary precautions required.

Castration

An increasing number of producers are no longer castrating bull calves. Rapidly maturing animals, if adequately fed, can reach market weight before undesirable sexual characteristics are developed. Nevertheless, most male animals are castrated; there are widely differing views regarding the desirability of operating at any particular age.

One to three months

Young calves suffer little setback if castrated at any time from birth to three months of age. There is little risk of flyborne infection when the calves are castrated at a young age because it is early in the season. In areas where urinary calculi are a problem, there is a greater risk of calculi occurring among animals that are castrated at a very young age. Moreover, many believe that poorer growth rates are achieved by the young castrated male.

Six to twelve months

If castration does not take place early in the season, wait until the fall when flies will be less abundant. The older the animal is at castration, the greater will be the risk of bleeding. There may be temporary reduction in growth rate.

Restraint

Young or small animals are most easily castrated when they have been thrown and hobbled. The noose of a length of rope is slipped around the fetlock; the free end is then passed around the calf's neck, pulled up tight, and tied with a quick release knot at the hock. The use of a calf table greatly simplifies the restraint of calves.

It is preferable to use a chute in the case of older animals. If a chute is not available, the animal may be tied to a fence with a halter, with an assistant pushing the calf into the fence and applying a tail jack at the same time. Tail jacking is an important means of controlling an animal, which can inflict considerable damage not only by kicking but also by driving the knife into the operator's hand.

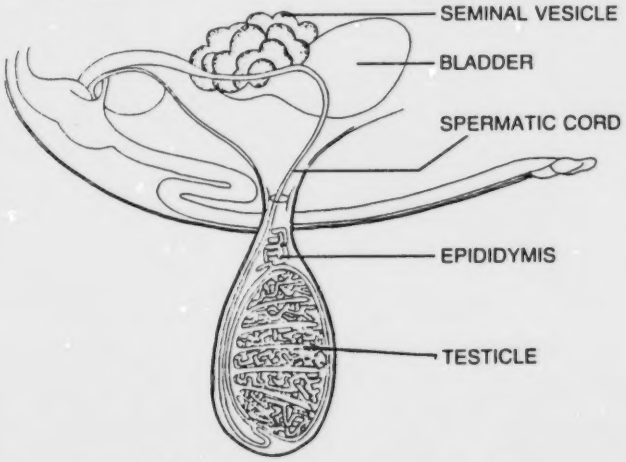


Figure 12 - Testicle and associated organs

Figure 13 - Methods of castrating

Castration techniques

The testicle lies inside the scrotum in a membranous bag. This bag is connected directly to the abdomen by means of a tube. Infection can pass along the tube and cause peritonitis, a serious complication.

The testicle is suspended by a cord which contains blood vessels. Where the cord is close to the testicle, these vessels are thickened and twisted. Cutting the cord low down will leave a large amount of clotted blood and tubules in the bag. Blood is an ideal medium for bacterial growth. Cutting too high is dangerous only if the animal bleeds and the cord has to be relocated later.

Sometimes parts of the membranous bag or cord will hang from the wound. This prevents healing and encourages infection.

Surgical techniques

- Use a sharp knife kept in a container filled with disinfectant solution.
- Wash your hand and the bull's scrotum using a surgical soap.
- Make a cut along the side of the scrotum to expose the testicle. The cut should be one-third longer than the testicle and extend down to the tip of the scrotum. Free the testicle from the membranes which should be peeled back up the cord. If the animal is over six months of age, an emasculator may be applied and left on for 30 seconds. Cut each side separately. For calves under six months of age, the testicles can be drawn without using an emasculator. In the case of young calves under two months, the whole of the bottom of the scrotum may be cut off. The two testicles will appear; each may be grasped and pulled completely out of the animal's body (figure 13).
- Confine the animal immediately after castration in a well bedded area or clean pasture (for cleanliness), and keep the animal quiet for three to four hours (to prevent bleeding).
- Keep animal under close observation for five days to observe swelling or stiffness (from infection). Fly sprays may be used if insects are a problem.
- Isolate the animal immediately if the wound swells or the animal becomes stiff and depressed. Call a veterinarian. The wound should be bathed with hot water and antibiotics should be administered. The veterinarian may open and drain the wound.

Bloodless castration

This is performed by crushing the cord and blood vessels that supply each testicle with a Burdizzo. Hold one testicle with its cord against the outer side of the scrotum and apply the instrument high on the cord and in such a manner that only the cord and a small area of scrotum are crushed. Ensure the penis is not included in the crushed tissues. Repeat the operation for the second testicle.

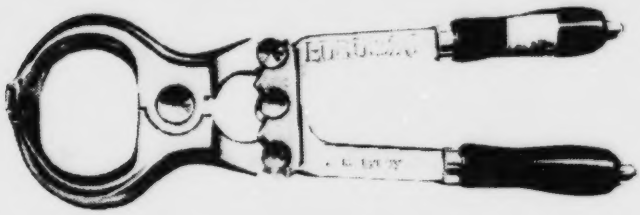


Figure 14 - Burdizzo emasculator

Another method of castration favored by some producers is the use of the Elastrator. This method involves holding both testicles in the bottom of the scrotum while applying a rubber ring to the top of the scrotum. Care must be taken to ensure that both testicles are in the lower scrotum before the rubber ring is applied.

Dehorning

The younger the calves are when dehorned the better the results and the lower the levels of stress inflicted on the animals.

Dehorning during first month of life

Caustic

Sticks of caustic may be purchased for the purpose; however, they are an irritant to the human hand and dangerous if allowed to run in the calf's eye. Caustic will cause problems if rubbed by the calf on the cow's udder. Although caustic may be applied without a local anaesthetic, it is certainly less difficult if the anaesthetic is given.

The hair around the area of the horn base should be clipped. If a horny tip is present, it may be cut off with a knife. Rub the caustic in using a circular movement and apply it over an area no bigger than a quarter. The procedure is complete when the area of application is burnt to just below the skin level. Continued application will damage the bone. The wounds should be allowed to dry before the calf is returned to the mother. Drying prevents the caustic from rubbing off on the cow's udder and burning the skin. In no case should disbudding take place if there is a risk of rain, as the caustic will run, burn the face, and perhaps damage the eye of the calf.

Electric dehorning

Electric dehorners or a hot iron can be used very successfully on young calves up to two months of age.

After the iron has been heated to the proper temperature, it is pressed firmly over the horn button and held until the underlying tissue has been cauterized. The burn must be deep enough to destroy the horn tissue but not so deep as to produce a bad sore. Generally, enough heat has been applied when the hot iron is removed and the skin around the base of the horn has a smooth brown leather-like appearance as with a proper brand.

Many producers are using the electric dehorning technique or a specially made iron heated in a branding fire. The ring should be smooth and have no more than a 4-5 cm outside diameter.

Very little after care is required with this technique. The cauterized area will peel off with the horn bud within four to six weeks, leaving the calves resembling naturally-polled animals.

Dehorning from two to five months of age

This is usually not a good age for dehorning because of the risk of flies in the summer season. Various instruments are available, but probably the most commonly used one is the gouger. When used properly, the horn is "scooped out" along with a ring of skin about 0.6 cm wide around the base of the horn. Whatever instrument is used, it should be cleaned and soaked in a disinfectant prior to its use and between use on calves.

Dehorning adult cattle

The horns of adult cattle are most easily and accurately removed if the procedure is performed under a local anaesthetic. If a good cosmetic result is desired, the surgery should be undertaken by a veterinarian.

Equipment

* Wire - the use of special cutting wire is slower and much harder physical work than any other system; however, the horn can be cut closer with minimal bleeding.
* Saws - various hand saws can be used, but once the direction of the cut has started, it cannot be changed and bleeding can be excessive.
* Shears - shears are extremely quick and reasonably accurate in skilled hands. For adult cattle, the shears tend to be extremely heavy and may splinter and crush bone rather than cut it, resulting in excessive hemorrhage.

Whenever an instrument is used, the objective must be to attempt to remove 0.6 cm of skin with the horn.

Bleeding

Bleeding at the time of surgery is usually profuse, but if the animals are kept quiet, the bleeding will normally stop.

If an aesthetic has been used, bleeders may be cauterized with a hot iron or ligated surgically. Dehorned animals will not recognize one another, and if they have been anaesthetized, they will tend to fight among themselves. If fighting takes place, the wounds are likely to open and begin bleeding again. Therefore, keep them separate. Animals that have not been anaesthetized will be too sore to fight.

When bleeding persists for more than 45 minutes, apply pressure to the wound by means of a gauze pad and bandage. Should bleeding still continue, obtain the assistance of a veterinarian.

Various preparations are available for general use that will assist in stimulating the clotting of blood.

Complications

The horn is hollow and leads directly into the large sinuses of the head. Thus, when the horn is removed, the sinus will be exposed to the outside air.

Frequently, rain will fall in the opening, or dirt will be pushed into the opening when the animal rubs its head during the "itchy" healing stage. Sinusitis may result. The animal will suffer from a headache, the eye on the infected side will tend to close and the animal will hang its head to one side. Discharge, if present, may be tipped out by turning the head on one side. Antibiotics such as mastitis ointment are usually quite effective if squirted into the opening. If the discharge has a foul smell, seek veterinary attention. If the opening has healed over but the same symptoms are seen, call a veterinarian.

WARNING: *Both castration and dehorning present the same dangers from the following:*

- *Bleeding* - mouldy sweet clover may contain dicumerol, an agent that prevents normal blood clotting. Ensure that it is not fed for two weeks prior to surgery. Twenty-four hour observation following surgery is essential because bleeding may occur in this period if dehorned cattle fight (if mixed in with strange animals) or are subjected to violent exercise.
- *Infection* - Protect wound from infection for several days after surgery.

Growth Implants

Growth implants have been in common use for a number of years to increase the rate of gain for nursing calves, weaned calves and feedlot cattle. Implants consistently provide a return several times greater than the cost of implanting.

Table 19 outlines the various implants showing approvals for use, approval for reimplantation, active ingredients, effective period and pre-slaughter withdrawal period.

Ralgro^{R} (Zeranol) is a mold extract, which stimulates the animal to produce growth hormones. The other implants are natural hormone products, which directly stimulate growth. When

Table 19
Implant Summary List

	Ralgro	Synovex-S	Synovex-H	Synovex-C	Compudose	Steeroid	Heiferoid
Manufacturer	International Mineral and Chemical Corp.	Syntex Agribusiness	Syntex Agribusiness	Syntex Agribusiness	Elanco Div. of Eli Lilly Canada Inc.	Boehringer Ingelheim Canada Ltd.	Roehringer Ingelheim Canada Ltd.
Active ingredient	zeranol	estradiol-benzoate and progesterone	estradiol-benzoate and testosterone	estradiol-benzoate and progesterone	estradiol-17 beta	estradiol-benzoate and progesterone	estradiol-benzoate and testosterone
Withdrawal Period	65 days	no	no	no	no	no	no
Effective Period (when properly implanted)	120 days	140 days	140 days	birth to weaning	200 days	175 + days	175 + days
Approved for use on: Suckling calves (45 days or older)	yes	no	no	yes	no	no	no
Steers over 400 pounds	yes	yes	no	no	no	yes	no
Heifers over 400 pounds	yes	no	yes	no	no	no	yes
Steers over 600 pounds	yes	yes	no	no	yes	yes	no
Heifers over 600 pounds	yes	no	yes	no	no	no	yes
Pasture cattle	yes	yes	yes	no	yes	yes	yes
Breeding cattle	no	no	no	heifer calves 45-90 days of age	no	no	no
Implant site	middle of ear	middle of ear	middle of ear	middle of ear	middle of ear	middle of ear	middle of ear
Registered in Canada for reimplanting	yes	yes	no	reimplant at weaning with Synovex-S/H	no	no	no

deciding which implant to buy, consider two things. First, the amount of additional gain the implant can give. Second, the time period in which the implant has to work. Depending on the management situation, such as cattle not being handled for long periods of time, a longer acting implant like Compudose may be preferred.

Alberta trials conducted with yearling cattle showed increased weight gains of 9 to 23 kg (20 to 50 lb) over weight gains of their unimplanted penmates. Suckling calves given a single implant in the spring can usually be expected to gain 4.5 to 9 kg (10 to 20 lb) more than untreated calves.

In both calves and yearlings, growth implants are likely to give the greatest response if the animals are on a diet that allows for reasonable weight gain. A shortage of milk or forage caused by drought or a deficiency of any essential nutrient in the diet will reduce the animal's ability to realize its maximum potential for growth. In this kind of situation, the response from the growth implants may be less than expected.

Proper location of the implant is important. Follow the label directions to ensure the implant is placed where the manufacturer specifies. Growth implants are placed between the skin and cartilage of the animal's ear to allow slow release of the active ingredient into the animal's bloodstream. Check the label to determine if a preslaughter withdrawal period is required.

Trial results show that implanting bull calves will result in reduced weight, length and maximum circumference of the testicles. Bull calves to be used for breeding should not be implanted. However, if the animals are intended for slaughter, implants usually reduce bulling and make the bulls more docile. Implanted bulls exhibit increased weight gains.

The effects of implanting on sexual development of heifer calves are mixed. Heifer calves given single or multiple implants have had delayed estrus and reduced fertility in some trials, while in others no differences from unimplanted animals have been noted. However, concern increases with the number of times the animal is reimplanted. Before implanting heifers that may be used for breeding, make sure the implant is approved for this use.

Creep Feeding

Cows and calves grazing summer pasture provide the least expensive production system for the beef producer. A cow on good pasture can usually meet her nutritional requirements for optimum milk production, although phosphorus and trace mineral supplementation may be required. Calves on milk plus good pasture should gain 0.7 to 0.9 kg (1.5 to 2.0 lb) per day depending on the milk production capability of the dam.

Opinions vary on the merit of creep feeding.

Advantages are:

- When pastures dry up in September and October, not even the best milking cow will give enough milk for an early March calf. Calves will often lose weight for the last two months before weaning if they are on poor pasture.
- Creep feeding makes the weaning change-over easier because calves are already started on feed.
- Gains are put on very efficiently, without danger of overfeeding at an early age.
- Creep feeding may reduce "stealing" which many calves of the larger breeds seem to do.
- Pasture management can be improved since a calf receiving grain will consume less grass.

Disadvantages are:

- Creep feeding can distort the production record on the cow and the performance information on the calf. The weaning weight no longer reflects the cow's milking ability, but also the amount of grain the calf consumed.
- Feedlot operators may discriminate against calves that appear to have some degree of finish, as often is the case with creep fed calves.
- Some calves eat a fair amount of creep feed while some will not eat any.
- The added cost of creep feeders, grain and labor may not be justified if feed prices are high or pasture conditions are good.
- Heifer calves that are overfed in the creep feeder may fatten excessively. Some of this fat will be deposited in the udder resulting in reduced milk production when they start to produce calves themselves, leading to reduced weaning weights.

Many different creep feeds are available. The best creep feed is the one that is least expensive yet is palatable and contains approximately:

- 1.35 Mcals of digestible energy/lb
- 13.5% crude protein
- 0.6% calcium
- 0.5% phosphorus
- vitamins A, D and E (and selenium if recommended for the area)
- cobalt iodized salt or TM salt where no other source of trace minerals is used to make the creep feed.

An example of a creep feed supplying these nutrients is:

Barley	85%
32% Supplement	15%
	100%

A creep feed may be purchased or it may be mixed at home using home grown grains plus supplements. Supplements are necessary to provide adequate levels of protein, minerals and vitamins.

If creep fed calves have access to feed starting at six weeks to two months of age, they will consume up to 227 kg (500 lb) of grain mix and may weigh up to 27 kg (60 lb) more at weaning time than noncreep fed calves. The cost of the feed, equipment and labor compared with the increased value of the heavier calf will determine whether or not creep feeding will pay.

Weaning program

Beef calves are typically weaned, hauled to an auction market, sold through the ring, and shipped to a feedlot over a period of a few days under our present marketing system. This method of marketing combined with processing on arrival at the feedlot and adaptation to feedlot conditions creates marked stress on feeder calves. Stress-related diseases, such as shipping fever, often account for over 75 per cent of the cattle losses in feedlots. Disease problems resulting from stress are much more severe with calves than with yearlings. Data collected from feedlots show that approximately 2 per cent of the calves die after arrival at feedlots. Further losses occur because of shrink, sickness, treatment costs, and decreased production performance.

Most calves raised in Alberta are from herds of 50 cows or less. In the marketing process, it may be necessary to accumulate calves from several owners over several days to get enough calves for the feeder to fill a pen. Grouping calves that are unfamiliar with each other causes stress. As well, calves from different sources may carry diseases to which others in the group may not have developed an immunity. These stresses reoccur each time new calves are added to the pen.

Preconditioning

Preconditioning is a management program designed to reduce the economic loss caused by stress and disease during the movement of calves from the cow herd to the feedlot. Calves that are weaned, vaccinated, and started on feed by the producer are much better prepared to withstand this stress. Preconditioned calves are often sold at organized sales each fall. Thus, it is a marketing program as well as a health program.

Preconditioning is not a new idea. The requirements associated with preconditioning are sound management practices, which have been followed by some producers for many years. The Alberta Certified Preconditioned Feeder Program (ACPF) was developed in 1980 and its successful operation is dependent upon the co-operation of producers, veterinarians, auction market personnel and the staff of Alberta Agriculture.

The aim of the ACPF program is to reduce the stress encountered by calves as they enter the feedlot. This is accomplished in three ways:

- adapting the calf to the feedlot environment prior to shipment
- reducing stress by spreading stress-factors over a longer period so that the effects are not compounded
- vaccinating the calf for diseases associated with feedlots before they contact with these diseases.

Alberta preconditioned requirements

The requirements are flexible enough to allow producers to develop unique programs that still fulfill the minimum standards. Other vaccinations and management practices can be added at the discretion of the producers. Information on the feeding program and breeding background is also recorded on the preconditioning certificates.

In the Alberta certified preconditioned feeder (ACPF) program, preconditioned calves must be:

- at least four months of age prior to being vaccinated
- owned by the operator 45 days prior to sale or shipment
- castrated and dehorned at least three weeks prior to sale or shipment
- vaccinated with IBR/PI$_3$ and multiclostridial (7-way or 8-way) vaccine three weeks prior to sale or shipment
- treated for warble grubs at least three weeks prior to sale or shipment
- weaned for a minimum of 45 days
- tagged with a green ACPF ear tag in the right ear
- accompanied by an official ACPF certificate completed and signed by both the veterinarian and the producer.

This is what the ACPF has accomplished:

- since 1980, over 60,000 calves have been preconditioned
- the average price premium for preconditioned calves from 1980 to 1985 is
- $ 5.08 cwt for steers and $ 4.17 cwt for heifers
- preconditioned calves are 40 to 60 or more pounds heavier than unweaned calves
- preconditioning reduces sickness and death losses of calves in feedlots by over 50 per cent.

Recommended procedures

These procedures are recommended to producers whether they are taking part in the ACPF program or weaning replacements for their own use:

- Castrate and dehorn in early summer at birth or branding.
- Vaccinate the calves with mandatory vaccines as well as others you may be using 2 to 3 weeks prior to weaning.
- Start the calves on creep feed 2 to 3 weeks prior to weaning. Whole oats or other creep feeds are adequate for starting calves.
- Move the cows and calves to the preconditioning area two to three days before weaning. Keeping the cows present, allow the calf to adapt to the pens, feeders, and waterers before weaning. During this time continue to creep feed the calves but do not feed the cows. This will reduce the cow's milk and increase consumption of the preconditioning ration by calves. At weaning, remove the cows from the pens, leaving the calves behind.
- Attempt to wean calves 8 weeks before they are sold. Although the minimum requirement is 45 days, the extra time should result in healthier calves and better gains over the preconditioning period.

- Aim for calf gain of 0.7 - 1.2 kg (1.5 - 2.5 lb) per day during the preconditioning period. The actual gains will depend upon breed, type, size, sex, market requirements, etc. To achieve this gain, calves must be started on grain as soon as possible before weaning and should consume 2.3 - 4.5 kg (5-10 lb) of grain daily over the entire preconditioning period. Rations need not be complicated or expensive. Home grown grain supplemented with low urea protein supplement, minerals and vitamins and home grown, good quality forages are all that is necessary.
- Attempt to wean calves early enough that cows can increase body condition before winter. This should reduce winter feed requirements and increase the calf crop weaned in the following years.

Developing replacement heifers

The key to producing top quality fertile cows involves proper management of the cow from the time she is a calf. To produce the maximum number of calves in her lifetime, a cow must calve each year, starting as a two-year-old.

Table 15 shows that first-calf heifers are slower to return to estrus following calving and, therefore, should be bred to calve 20 to 30 days before the older cows in the herd, If heifers are to calve at this time, they must be bred by 14 months of age.

Puberty

Puberty is the time at which a heifer shows a fertile estrus, and developes a corpus luteum necessary for sustaining pregnancy. This is the period in a heifer's life when she becomes capable of reproducing; it can occur between 7 and 14 months of age. The age and weight at which a heifer reaches puberty is influenced by several factors including level of nutrition, breed, growth rate, and heterosis (cross-breeding effect). There is

Table 20
The effect of breed, age and weight on puberty

Breed of Sire	% Reaching puberty at 15 months	Average age at puberty (Days)	Average weight at puberty	
			kg	lb
Hereford	96	375[B]	272	600
Angus	97	353	254	560
Hereford x Angus	97	377	268	590
Brown Swiss	97	347	277	611
Brahman	80-95	400-412[C]	320-325	706-716
Charolais	96	399	294-305	648-673
Chianina	60-85	398-455	318-342	702-755
Devon	98	385	276	609
Gelbvieh	95-99	341-365	282-285	622-628
Holstein	99	369	274	604
Jersey	92	328-368	221-278	487-613
Limousin	92	399-402	292-301	644-664
Maine Anjou	99	371-402	302-305	665-672
Pinzgauer	96	309	284	626
Red Poll	95-100	360-368	264-274	581-605
Simmental	95	369-375	288	636
South Devon	87-95	365-382	273-281	602-619
Tarentaise	100	326	284	626

Source: USDA Clay Centre 1973 - 77 Reports
B 375 days = 12.3 months
C 412 days = 13.6 months

a marked difference in age at puberty among breeds (table 20). The British breeds tend to reach puberty earlier than cattle such as the Brahman, which has zebu blood. Some of the exotic breeds generally attain a higher body weight and greater age before reaching puberty.

The United States Meat Animal Research Centre has studied age and weight of heifers at puberty as one aspect of breed comparison studies. The results of these studies indicate that crossbred heifers of the exotic breeds should be at least 14 months of age in order to have a higher percentage of the heifers cycling when the breeding season begins. In addition, they should be in the 340 to 352 kg (750 to 775 lb) range for weight when breeding commences (table 21). Most British breed heifers should be a minimum of 14 months of age and 318 kg (700 lb) in weight at the start of the breeding season.

Inadequate levels of nutrition will cause a low percentage of heifers to show estrus at breeding time. This can result in 50 per cent of the heifers being open at the end of the breeding season. Development of heifers to attain reproductive efficiency can be accomplished by feeding supplemental grain with the roughage ration (see nutrition section for grain-roughage combinations).

If replacement heifers are not gaining 0.57 to 0.68 kg (1.25 lb to 1.5 lb) per day from weaning to start of the breeding season, the amount of grain in the ration should be increased until they do gain at this rate. To successfully breed heifers at 14 to 15 months of age, the following minimum weights should be attained:

Table 21
Recommended minimum weights at first breeding

	kilograms	pounds
Hereford	318	700
Angus	295	650
Angus x Hereford	318	700
Charolais & Charolais x British	340	750
Limousin & Limousin x British	340	750
Simmental & Simmental x British	340	750

Breeding yearling heifers

As has previously been discussed, replacement heifers should have been born early in the calving season and should have been fed to gain 0.57 to 0.68 kg (1.25 to 1.5 lb) per day from weaning to the start of the breeding season. Providing sufficient feed has been emphasized. The other side of the coin is overfeeding, resulting in excessive fatness at the time of puberty. This tends to cause fat cells to displace milk tissue which can permanently damage the heifer's potential for milk production.

Because some of the heifers will not cycle, put 50 per cent more heifers out to breed than will be needed. By limiting these heifers to a 45-day breeding season, early calves are guaranteed the next spring. This provides the necessary opportunity for the first calf heifer to have sufficient time to prepare for rebreeding with the main herd in the following year.

If more replacement heifers are in calf than are required to replace culled cows, the heifers themselves can be culled on the basis of their preweaning test records (see discussion on ROP in this section).

Calving difficulty in heifers

Calving difficulty or dystocia in heifers is caused by undersized heifers or oversized calves. These are not one and the same. Birth weight or size is controlled mainly by genetics. Because it is heritable, selection of the proper bulls to breed to yearling heifers is important.

Nutrition during pregnancy has only a minimal effect on birth weight unless a severe restriction in energy is imposed. Even when low levels of energy are fed, calving difficulty is not likely to be reduced. One example of this is illustrated by a study conducted in Australia with Hereford heifers that were fed three different energy levels over the last 120 days of pregnancy (table 22). Part of the reason calving difficulty is not reduced is that the restriction of energy impaired the

Table 22
Effect of nutrition on birth weight and calving difficulty in heifers

	High Plane (HP)	Maintenance Plane (MP)	Low Plane (LP)
ADG (kg) 12 Weeks Pre-Calving	0.70	-0.13	-0.56
Calf Birth Weight (kg)	29.9	26.8	23.4
Total Dystocia Cases/Total Calving	3/49	3/49	6/48

Source: Kroker and Cummins, 1979

growth of the heifer resulting in a smaller pelvic opening in the Lower Plane (LP) and Maintenance Plane (MP) groups. Furthermore the calves from the LP group of heifers took three times as long to stand and suckle after birth than did the calves from the High Plane (HP) group. Reproductive performance in the MP and LP group was also inferior to the HP group.

Based on this and other research, it is important that heifers be well grown out before their first calving to avoided dystocia, to maximized calf survivability, and to ensure rebreeding occurs within 60-90 days after calving. The target weights that indicate proper size at first calving are given in table 23 for some common breeds.

Table 23
Breed-weight relationships for adequate size at first calving

Breed	Weight (lb)
Hereford	950 - 975
Angus	925 - 950
Simmental	1000 - 1050
Charolais	1000 - 1050

Source: Ward, 1986

Selection of bulls for heifers

Normally a young bull should be used on heifers. This reduces risk of injury to the heifers breeding, as the heifer must support less weight than if she were bred by a mature bull.

Calving difficulties with heifers are caused by both the sire and the heifer herself. To minimize calving difficulties, select a bull that comes from a sire with a record for easy calving and was born unassisted, preferably with a light birth weight, or with a fine-boned structure. If an older bull is used, he should have a record for easy calving.

It is more important to select an easy calving bull within the chosen breed than to select a breed for easy calving. In general, sires from British breeds cause fewer calving problems than many of the larger European breeds.

Two-year-old heifers

The first lactation is probably the most critical time in a cow's life. The two-year-old heifer needs feed for both growth and milk production on top of that required for maintenance. It is very important to make sure she gets enough feed. It is doubly important for heifers from breeds with milking strain backgrounds. The only time it is not be necessary to supply these heifers with more feed than the rest of the herd is in years when spring pastures are exceptionally good. If virgin heifers are bred to drop their first calf early in the season (as recommended), pastures are that much more likely to be short for the first two months or so after calving. Special arrangements should be made to supply first calf heifers with extra feed during this period.

Selection and reproductive management of the bull

Introduction

The importance of the herd bull in beef production is often not fully appreciated. The bull or bulls selected to head up a herd can represent a large investment and influence the economic returns from the herd for several years. The herd bull not only determines the number of calves born, but will also affect the duration of the calving period, calving ease, the growth rate of the calves and eventually the genetic merit of the herd as determined by the herd replacements.

When selecting a herd bull, a breeder is generally looking for a high quality animal which, based on pedigree, performance or progeny information, has an ability to pass on these desirable qualities to his offspring. In addition, the bull must be able to sire a large number of calves during a short breeding season and be able to remain in a sound physical and healthy condition for a number of breeding seasons.

An understanding of functional reproductive physiology and management is important in selecting and maintaining a fertile bull battery.

The age at which a bull reaches sexual maturity or puberty will vary widely between and within breeds. Most bulls will reach puberty at 10 to 14 months of age, although it is common for a bull to have the desire and ability to mate as young as 7 months of age. As puberty approaches, there will be a change in body conformation, an increase in aggressiveness and sexual desire, and a rapid growth of the penis and testes.

The British breeds will generally reach puberty earlier than the larger exotic breeds. The nutritional status of the bull can also affect puberty because underfeeding will result in delayed puberty. While puberty is generally reached at one year of age, it should be remembered that bulls do not reach their maximum reproductive capacity until three or four years of age. For this reason yearling and two-year-old bulls should not be overused and should be kept on a proper plane of nutrition.

Bull selection

A balance between production and reproduction should be maintained when selecting a herd bull. The following factors should be kept in mind when evaluating a potential herd sire for your breeding program:

- genetic merit
- physical condition and health
- breeding soundness.

Genetic merit

The genetic merit of a bull can be estimated from his performance and progeny. His performance should be at least equal to the average of the herd from which he was produced or to the average of a group of bulls on test. Only traits that are medium to high in heritability and are economically important should receive major consideration in a breeding and selection program. Do not get carried away on small noneconomic points, such as breed character or color, which contribute little to productive efficiency or carcass quality.

Physical condition and health

The modern bull should have an ample amount of bone, adequate skeletal size as indicated by height and body length, better than average muscling, and a trim brisket and underline. This, in addition to the performance and pedigree of the bull, will be the only data considered by most producers. However, a bull with superior genetic potential cannot transmit this superiority unless his feet and legs are sound and he is able to seek out and breed cows in heat.

Young bulls such as yearlings and two-year-olds seldom have serious feet and leg abnormalities. At this age, sickle or straight hocks or overgrown hoofs should not be tolerated, even if it is not know how seriously these traits will affect walking and servicing capacity later in life. Any bulls showing arthritis should be culled without further consideration.

Transmissible diseases should always be of concern when selecting and bringing new bulls into the herd. Bulls should be purchased only from herds and sales where high health standards exist. Bulls should be examined and tested by a veterinarian before purchase, and isolated from the rest of the herd for at least 30 days after purchase.

Breeding soundness

Surveys conducted in Canada, the United States and Australia indicate that 10 to 20 per cent of the bulls examined for breeding soundness were sterile or had reduced fertility. With the high cost of purchasing and maintaining bulls, producers can no longer afford to compensate for this by running extra bulls in multi-sire breeding pastures.

At the present time, there is no accurate way to predict whether 100 per cent or 50 per cent of the cows exposed to a bull will conceive. However, through a breeding soundness examination prior to the breeding season, bulls of questionable or unsatisfactory breeding potential can be eliminated. This procedure will improve the chance of having an early, short calving period resulting in a greater number of heavier calves at weaning.

Many beef operators and bull sales now carry out some kind of routine breeding soundness examination. Such an evaluation gives some assurance that the bulls used for breeding will settle a high percentage of fertile cows.

A breeding soundness examination should evaluate a bull's:

- testicular and scrotal development
- semen quality and
- servicing capacity (libido).

Testicular and scrotal development

The testicles should be shaped like a football, be equal in size and hang uniformly between the rear legs in the scrotum. The testicles are raised and lowered by muscles in the wall of the scrotum and the spermatic cord to maintain a constant temperature for proper sperm development. Testicular growth is very rapid during the period from 6 to 14 months of age. Bulls should be fed well during this period because a low level of nutrition will result in slow testicle growth and small testicles at maturity.

The testicles have two primary functions: to produce sperm and to produce testosterone, the male sex hormone. Research has shown that testicle size, as measured by scrotal circumference, is closely related to sperm production. In other words, bulls with large testicles can be successfully mated to more cows than bulls with small testicles. A number of studies have also indicated that the bull's age and weight have a great effect on testicular development and size up to puberty. While the relationship between testicle size and semen production is not as great after reaching puberty, larger bulls will generally have larger testes than small bulls within the same breed.

The scrotal circumference (SC) of a bull can be easily and accurately measured using a commercially available flexible cloth or metal tape. After restraining the bull in a head gate, the testicles should be gently grasped at the neck of the scrotum. The testicles can then be pulled firmly down into the base of the scrotum by encircling its neck between the thumb and finger and pulling down on the testicles. The scrotal tape is formed into a loop, slipped over the scrotum and pulled snugly around the greatest diameter of the scrotum for a reading.

The breed, age, weight and fleshing of the bull must be taken into consideration when using the

scrotal measurement as an estimate of semen producing ability. Table 24 indicates scrotal circumferences for common beef breeds found in Western Canada.

Table 24
Scrotal circumference of yearling beef bulls

Breed	No. of Bulls	Average Scrotal Circumference (cm)
Aberdeen Angus	162	35.9
Blonde d'Aquitaine	43	33.9
Charolais	473	34.7
Hereford	663	34.8
Limousin	158	32.1
Maine Anjou	189	35.8
Shorthorn	102	34.5
Simmental	194	38.2

Source: *Coulter 1980*

Breeders, breed associations, veterinarians and researchers have established minimum scrotal measurements which a bull must meet for the breeding soundness examination. Yearling bulls with a scrotal circumference of 32 - 33 cm or greater generally have good semen quality and a good fertility rating. While this measurement is a good guide, it is by no means a guarantee of a fertile bull. The circumference below which a bull should be culled is not well established, although yearlings and two-year olds with less than 30 cm will likely be subfertile. If these bulls are used for breeding, a very low conception rate and a very lengthy calving period will result.

Semen quality

The quality of semen produced by the testicles is very important. A high percentage calf crop is dependent to a large degree on using males capable of producing high fertility semen. The firmness of the testicles provides an indication of the quality of semen produced. Testicles which are firm when manually palpated generally produce good quality semen, although an accurate evaluation can only be obtained by examining a semen sample. Testicles which are hard or very soft are suspect, and a breeding soundness examination should definitely include a semen evaluation.

Table 25
Relationship between semen quality and conception rate during natural mating

% Normal Sperm in Semen	No. of Bulls	Cows Bred	Cows Conceiving	Conception Rate
76 - 95%	27	339	192	57%
60 - 75%	6	90	53	59%
40 - 60%	9	139	55	40%
Less than 40%	9	126	37	29%

Source: *Wiltbank 1958*

Bulls with poor semen quality as measured by the percentage of normal sperm have low first estrus conception rates as indicated by table 25.

Semen quality can be determined by collecting a representative semen sample with an electro-ejaculator or artificial vagina. The semen sample can then be examined and evaluated with the naked eye and the microscope for color, volume, concentration, motility and morphology. Only qualified veterinarians and technicians should be used to collect and accurately evaluate a semen sample. If a semen sample is unsatisfactory, do not cull the bull immediately. An injury or sickness may have caused temporary infertility in the bull. It takes six to ten weeks from the time sperm begins to develop until mature sperm appear again in the ejaculate. A second semen evaluation should be carried out six to eight weeks later to determine if the bull is temporarily or permanently infertile.

Serving capacity

Having normal testicles and semen quality is of little value to a bull unless he has the desire to seek out cows in estrus and has the ability to mount and mate successfully.

Service capacity is the number of services a bull achieves under natural mating conditions over a period of time (one estrous cycle). A bull generally distributes his services equally over the cows in heat. Because cows serviced two or more times during a heat period have a higher pregnancy rate than those serviced once, the more services a bull can achieve during the breeding season, the more cows will be in calf. A bull's serving capacity during pasture breeding can be accurately predicted by exposing a bull to a number of restrained cows or heifers for a period of up to 40 minutes. The number of services during this period is a good indicator of a bull's servicing capacity under pasture breeding conditions. This test will detect those bulls with high and low libido as well as those with a broken penis or an arthritic condition that interferes with attempts to mount and mate.

Bulls with a high libido or serving capacity tend to have a much higher first estrus conception rate than low rating bulls, although the difference becomes less significant after the second or third estrous cycle. Table 26 outlines work carried out in Australia on measuring servicing capacity. Blockey observed the breeding behaviour of a number of bulls over a three week period. There was a wide variation in the numbers of heifers served among the bulls observed.

Table 26
Serving capacity of bulls

Bull No.	Serving Capacity in 3 weeks (No. of Services)	No. of Heifers Served
9	105	85
7	96	59
3	93	75
4	47	43
32	46	39
10	44	40
1	38	34
5	26	22
6	20	17
8	16	16
2	13	13
58	2	2

Source: *Blockey*

The number of services carried out during the three week pasture breeding period was very closely related to the serving evaluation rating of the bulls during their initial evaluation using restrained females. The service capacity test will no doubt receive more attention in the future as practical procedures are developed for use by breeders, bull test stations and bull sale organizations. One of the unfortunate concerns regarding service capacity is that it is not necessarily related to fertility. In other words, a bull with good semen quality may have a poor sex drive or vice versa.

Reproductive management of bull

Proper care and feeding of the herd sire, especially yearling bulls, is important to ensure optimum breeding performance over a number of years.

Nutrition

As pointed out earlier, proper levels of nutrition are very important especially in the young bull during sexual development. On the other hand, yearling and two-year-old bulls on a very high plane of nutrition often suffer from temporary sterility and low levels of fertility. It is not known whether such highly fitted bulls recover from this condition, although some such bulls placed in AI units for semen collection often recover after a period of time.

Handling bulls

Under a 90 day pasture breeding season, the bull-to-cow ratio can serve as a general guideline of the bull to cow ratio (table 27).

Table 27
Bull to cow ratio

Size or age of bull	Cows per bull
Small yearling	Up to 10
Large yearling	10 - 20
2 year old	20 - 30
3 years and over	30 - 40

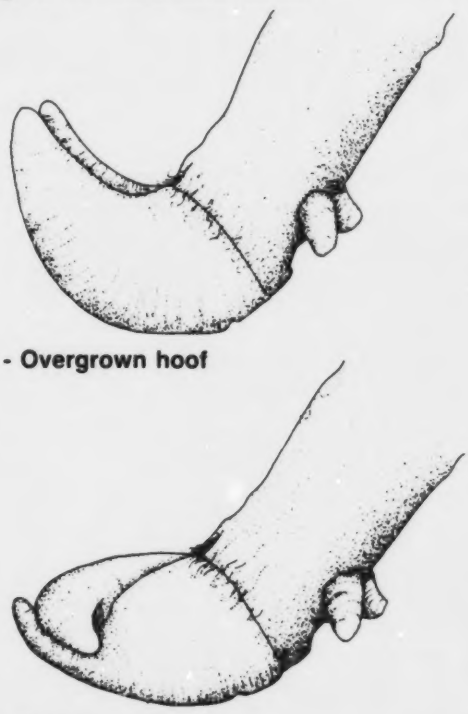
When running multi-sire breeding groups, young bulls should be kept separate from older bulls. Social ranking, generally based on the age of the bulls, can influence the sexual activity in a multi-sire breeding herd. A dominant bull sires more offspring but does not necessarily have the highest sex drive, nor is he always the largest or fastest growing bull in the group.

Where applicable, it is a good idea to give bulls a three to four day rest every 10 - 14 days, particularly if they are yearlings. Rotation of bulls among pastures is also a good management practice if feasible.

Hoof trimming

Breeding stock, particularly bulls, frequently suffer from overgrowth of the horny hoof. This extra growth on the hoof makes it difficult for animals to move around in search of pasture and can materially affect a bull's reproductive capacity.

Figure 15 - Hoof deformities



A - Overgrown hoof

B - Scissor hoof

Hoof trimming is probably most profitably carried out in the spring. Professional hoof trimmers may be employed. Veterinarians are often willing to undertake this work and should be employed for trimming hooves of valuable or lame animals. Producers can effectively trim feet provided that they are willing to equip themselves with the proper facilities and tools.

Equipment and Facilities

If only a few animals require attention, the work can be undertaken in a chute; however, it is much preferable to acquire a portable table.

Hoof shears or double action cutters of various patterns are available on the market; solidly constructed equipment is a good investment. A heavy duty rotary sander makes the task easier. Both left and right-handed hoof knives and a sharpening file are important additions to the equipment list. Kopertox dressing and bandages should also be available.

Anatomy and technique

The sole of the hoof is normally concave with the outside rim of the hoof bearing the weight of the animal. Overgrowth of the horn-like material destroys this arrangement. After hoof trimming, the outer rim of the hoof should be left slightly longer than the edges next to the cleft between the toes. Be careful not to cut the toes off.

Try to remove horn from under the toes until the length of the hoof approaches normal. The horn under the heel is normally thicker than at the toe. Excessive paring in the heel region may lead to damage of the sensitive structures under the sole.

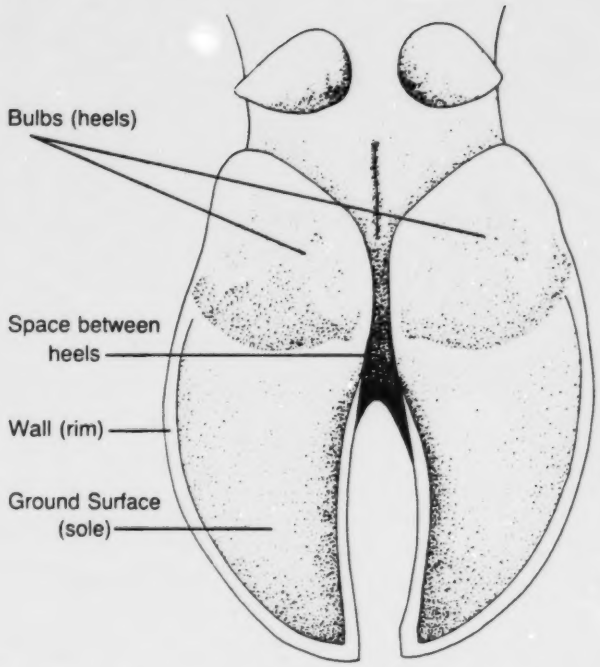


Figure 16 - Parts of the hoof

Artificial insemination

Introduction

Although artificial insemination (AI) service has been available to producers in Canada for nearly 40 years, it has been adopted slowly by the beef industry. While over 55 per cent of Canadian dairy cattle are bred by AI, less than 5 per cent of our beef cows are serviced this way.

Interest in the European breeds of beef cattle in the early '70s stimulated the use of AI, But a declining beef market and rising production costs caused a subsequent decline in its use. Recent developments in controlled breeding through the use of heat synchronization now makes AI more practical for use in beef herds.

Advantages of using artificial insemination

- AI provides the opportunity to use bulls of superior genetic producing ability. Most of the beef bulls in AI Studs have been performance tested and additional information on the progency's performance is available.
- AI can reduce the threat of venereal disease and lessen the possibility of delayed conception caused by sterile sires.
- AI permits the use of more than one bull or breed in breeding programs. The problems of rotating bulls and maintaining separate breeding pastures is minimized by using AI.
- It is generally less expensive to use AI than to purchase and keep a top quality bull throughout the year.

- The individual cow and herd records will identify the sire and breeding date, which will allow a better evaluation of sire performance and a prediction of calving dates.

Disadvantages of artificial insemination

- An AI program requires more time and skill, especially in the initial phases of the program compared to a pasture mating program.
- Cow identification, handling facilities and breeding pastures must be available.
- Heat detection should be carried out twice per day on the breeding herd.
- The level of herd management and nutrition is more critical in an AI program than in a natural service program.

Managing your AI program

The success of an AI program requires top level management. Many decisions regarding feeding, facilities, heat detection, sire selection, etc. will be necessary. The use of all available information and the experience gained by other successful users of AI will help the producer in developing an AI program for his/her herd.

Identification and record keeping

Individual identification of all cows in the herd is essential. Ear tags are the most popular, and several kinds are available. Neck chain numbers and branding are other excellent means of identification.

Whatever method is used, the numbers should be readable from a distance to allow for easy identification during heat detection.

Accurate records are important in an AI program. Calving dates, dates and times of estrus and breeding should be kept on all cows in the herd. Use a pocket record book and transfer the pertinent information to the herd's permanent records. These records can be used later to evaluate the results of the AI program.

Heat detection

Detection of heat requires considerable effort and time, but it is extremely important to a successful AI breeding program. To master the skill of heat detection, one must understand the behavioral signs a cow exhibits before, during and after estrus. The surest sign of heat or estrus is when a cow stands to be ridden by a bull, another cow or a steer. Cows exhibiting mounting behavior or other signs of sexual activity may not actually be in heat. However, there are a number of helpful indicators that will assist with heat detection.

A cow in heat will often be restless and may be seen walking the fence line and bawling. She may try to ride other cattle not in heat and may congregate with other sexually active cows that are approaching or going out of heat. Other signs of heat are a moist, swollen and reddened vulva and often a clear mucous discharge from the vagina.

Heat detection aids

Several aids have been developed to help with heat detection. These aids can be attached to the cows being observed for heat, or can be attached to detector animals. Pressure-sensitive devices such as the KaMar Heatmount Detector may be fixed to the tailhead area of the cow. When the cow comes in heat and is mounted, the pressure-sensitive device changes color. However, this marker should be used with caution as pressure from other things besides a mounting animal may also trigger the device.

The use of heat detector animals with chin ball markers to identify cows in heat have become very popular. Gomer bulls, androgenized cows, or steers can be fitted with halters equipped with chinball markers. These markers will leave a strip of paint on the back of a cow when she is mounted. Again, this heat detection aid must be used with caution, as a marker animal may not mount all animals in heat on a particular day or a cow may be mounted and marked when not in heat, particularly if the herd is kept in close confinement. Gomer bulls are animals that have been surgically altered by vasectomy penectomy, or surgical deviation of the penis or have had a pen-o-block inserted in the sheath to prevent mating. Androgenized cows have been treated with male sex hormones to make them behave like bulls in the presence of cows in heat.

Although heat detection aids can be very helpful, there is no substitute for a skilled person who examines the herd at least twice a day to detect which cows are in heat.

Time of insemination

The period of standing heat normally lasts 12 to 18 hours. As nearly one-quarter of the cows exhibit heat for 8 hours or less, and one-third of the cows are in heat 16 hours or more, it is generally recommended that the cows be observed at least twice daily. In addition, since mounting activity occurs at about 20-minute intervals, it is also recommended that each observation period last at least 30 minutes. Generally, more cows are first observed in heat in the early morning than in the evening. A noon observation will generally pick

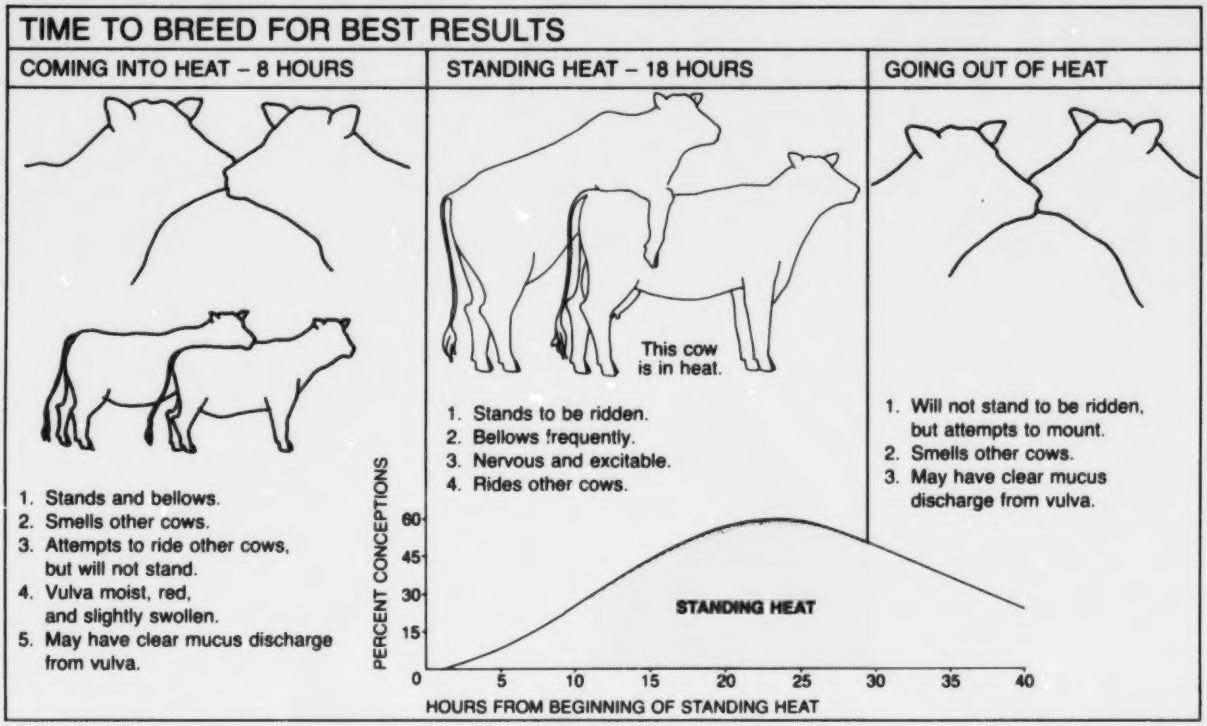


Figure 17 - Time to breed for best results

up the lowest percentage of cows in heat. Cows ovulate between 18 to 30 hours after the onset of estrus. Optimum conception rates occur when sperm is deposited in the female tract about 4 hours before ovulation. However, recent research has shown conception rates are comparable when all inseminations are done between 10 a.m. and noon. In other words, cows first observed in estrus in the morning would be inseminated between 10 a.m. and noon that same day, while cows first observed in estrus at the evening heat detection period would be inseminated the following day between 10 a.m. and noon. Many of the cows observed to be in heat during the early morning heat detection period may have begun their estrus the previous evening. Waiting until the afternoon to inseminate those cows would be too late for optimum fertility rates. Figure 17 outlines in graphic form the indications of heat and when a cow should be bred for the best results.

Factors affecting cow fertility

Cow fertility, an often underestimated problem in a normal breeding program, becomes particularly important in an AI program. One of the reasons it has become a major concern is that with the increasing use of AI records, we are now able to identify low fertility more readily. Cow fertility may be measured by the number of services per conception, days from calving to first heat, breeding season length, pregnancy rate or percent open.

Fertility is closely associated with nutrition both before and after calving, an adequate recovery period between calving and breeding, and freedom from diseases and other abnormalities. Proper nutrition must be furnished 12 months of the year. Research has conclusively demonstrated that cows on a proper plane of nutrition both before and after calving will come into heat sooner and conceive more readily.

Sire selection

One of the advantages of using AI is the opportunity it gives to select beef sires with superior genetic traits. Some of the best sires in the world are available through your local AI stud. Top performance and progeny tested sires are available at a reasonable cost. If you are using AI, select the kind of bull that is best for you. Information on the performance of a progeny tested bull should include data such as birth weight, weaning weight, ease of calving, postweaning gain and yearling weight of his offspring. These data along with fertility rating (nonreturn rate) should be used in selecting the sire or sires to be used in the AI breeding program. Sire selection is just as important when using AI as it is in natural service. Remember that all bulls available through AI are not necessarily genetically superior for the traits in which you are interested.

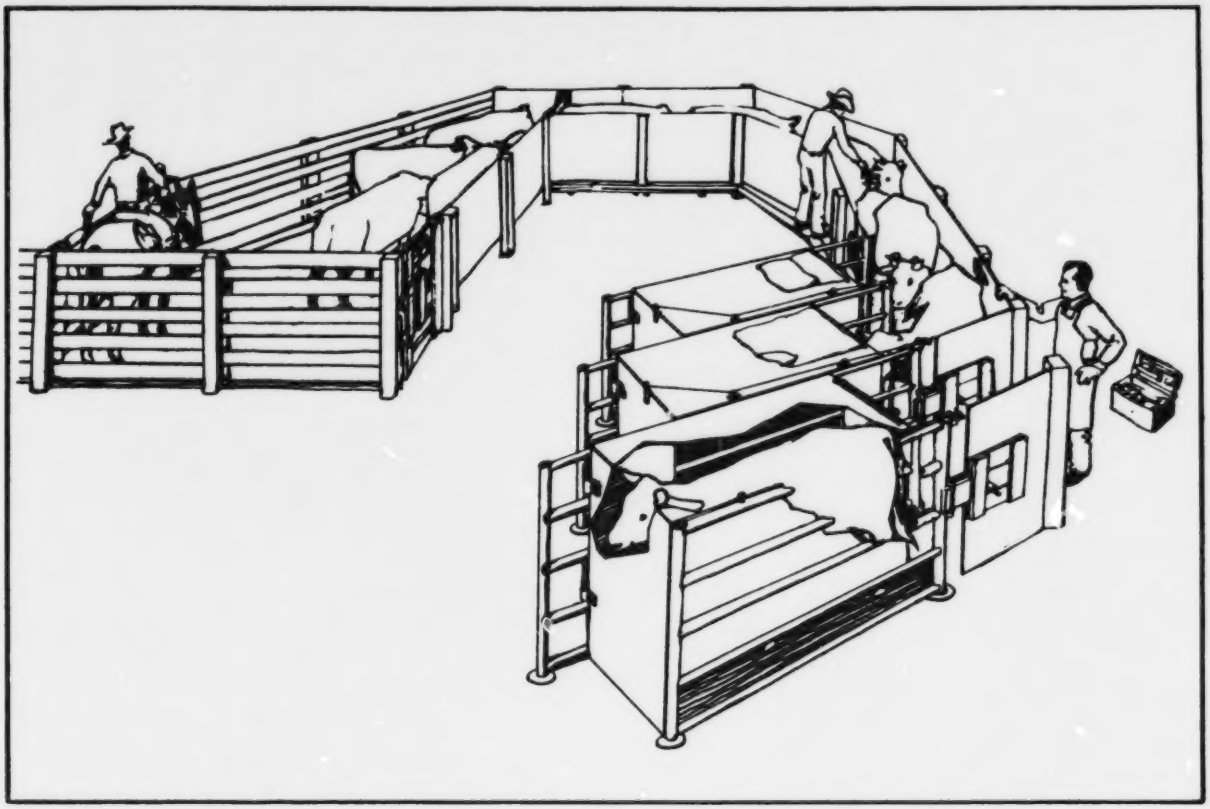


Figure 18 - Herringbone AI breeding chute

Semen quality and handling

The various AI studs and artificial insemination businesses in Alberta are the principal sources of semen and supplies. While individual breeders may offer semen for sale, a sample should be checked at an AI stud or Alberta Agriculture semen evaluation lab before it is used. Top quality semen, which has been properly handled and stored, must be used if the desired results are to be obtained.

If the herd is to be bred by someone else, make sure the insemination is done by a reputable technician. If the herd owner is breeding the herd, he should make sure that semen and supplies are on hand well in advance of the first breeding date. Semen is available in various sized vials and straws. The recommendations of the semen producing business should be followed explicitly in the thawing and handling of the semen.

Breeding pasture and facilities

The breeding herd should be placed in a small level pasture, which is relatively free of trees and gullies, so that cows can be easily observed for heat. The pasture should supply ample feed and water should be available for the duration of the AI program. If feed and water supplies are a problem, fewer cows should be placed on the program or supplemental feed can be supplied. In fact a 10-12 day synchronized program can be made to work quite successfully under feedlot or winter feeding conditions.

Proper handling facilities are often overlooked in an AI breeding program. A well-designed cattle handling facility removes the frustration often associated with inseminating cattle. Keeping excitement and stress to a minimum will pay dividends in a higher conception rate.

The holding pens and breeding chute should be built as close as possible to the breeding pastures. When it is time to inseminate, the cattle should be moved as gently as possible into a shaded area where they can be held and bred without exposure to the hot sun or rainy conditions. A roof over the chute and the breeding area will protect the inseminator and the semen from adverse conditions. The breeding chute and corrals should be used for breeding only and should not be used for any other management activity where the cows have been under stress.

Elaborate facilities are not necessary, but if a large number of cows are going to be bred year after year, particularly if they are being synchronized, then a substantial investment is warranted.

The AI facilities should consist of a sorting

alley, holding pens and a breeding chute. Cattle tend to follow a curved path more easily than follow a straight path. With a curved chute, cattle cannot see the AI chute until they are practically in it. If a large beef herd is on a synchronized estrus program, then consideration should be given to several AI chutes.

Many cattle breeders have found that the best way to keep cattle calm and easy to handle during insemination is to use a dark box chute that does not have a head gate. The cow being inseminated is held in a totally enclosed dark chute with the top, side and front gate completely solid with the exception of a small 15 x 30 mm window in the front of the gate. This window helps entice the cow to enter the dark chute. The dark chute (figure 18) is simple to build and can be modified to accommodate various sized animals. Plans for beef cattle corrals and breeding chutes are available from your local district agriculturist.

Controlled breeding program

Prostaglandins have made estrus synchronization possible in the beef herd. An injection of the hormone-like substance enables producers to control the estrous cycle of the cow so she can be bred at a specific time by AI. On a herd basis, a large percentage of the cows can be synchronized to come into heat during a short period of time and can be inseminated during a single insemination period. This procedure eliminates the need for daily heat detection over the usual three to six week AI breeding period and allows for the efficient use of labor when the injection and the insemination of the herd is done.

Various controlled breeding programs are available to meet the different breeding and management systems found on beef farms and ranches. The factors necessary for a successful AI program are even more important under a controlled breeding program. The program must be well coordinated so that only normally cycling cows are selected and a qualified AI technician is available to inseminate the herd at the ideal time.

Clean-up bulls

Two of the important factors in an AI beef breeding program are the length of the breeding season and the use of clean-up bulls. Under most AI breeding programs, it is impractical to breed by AI alone or to expect all cows to settle after their first service. The amount of feed available in the breeding pasture and the amount of labor available for heat detection will often determine the length of the AI breeding program.

While a four to six week AI breeding program was popular in the past, the trend today is for the 10-12 day synchronized program or the 20 day (one heat cycle) program.

A timed insemination program (two injections of prostaglandin) should result in a 50-60 per cent conception rate, while the 10-12 day synchronization program or the 21-day breeding program where cows are bred after heat detection should result in a 65 to 80 per cent conception rate.

An expected conception rate of 50 per cent will require one clean-up bull for 50 cows, while a 65 per cent rate will require one bull for 75 cows.

Summary

The guidelines for a successful AI program:

- Plan your breeding program well in advance.
- Identify all cows and keep reproduction records on the herd.
- Make sure the cow herd has an adequate level of nutrition both before and after calving.
- Heat detect twice each day.
- Obtain AI technician services and bull semen from a reputable insemination business.
- Develop good handling facilities.

Cow-Calf Nutrition

The cost of feed is a major part of the total cost of production in a cow-calf operation. This cost often goes unnoticed in the summer when animals are out on pasture. In the winter, however, feed costs become obvious. Even home-grown feeds have specific costs of production attributable to them. Therefore, the winter feeding period, with its increased costs, will generally be of more concern than the summer period.

The winter months are also important because they make up most of the gestation period for the herd. Proper feeding during the gestation period and between calving and breeding are essential for good reproductive performance and calf productivity.

This section will focus on the winter feeding period as it is generally more critical than the summer. Some comments will be made about the supplementation needs of cattle on pasture. This does not mean that proper nutrition can be ignored in the summer months. Inadequate nutrition at any time of year can result in lowered reproductive

Table 28
Average nutrient content of commonly used Alberta feeds

	Moisture (%)	Estimated Digestible Energy (Mcal/kg)	(Mcal/lb)	Acid Detergent Fibre (%)	Protein (%)	Calcium %	Phos. %
Hay							
Alfalfa	11.0	2.60	1.18	34.5	16.9	1.65	0.21
Clover	11.3	2.53	1.15	45.4	13.0	1.18	0.19
Alfalfa-grass	10.8	2.42	1.10	38.2	13.1	1.12	0.19
Brome	9.8	2.24	1.02	38.4	8.8	0.43	0.15
Timothy	9.4	2.18	0.99	40.0	7.6	0.43	0.15
Native	9.1	2.13	0.97	40.2	8.0	0.44	0.13
Greenfeed							
Mixed Cereal	13.0	2.64	1.20	35.1	9.3	0.32	0.23
Barley	12.6	2.64	1.20	34.3	10.0	0.35	0.25
Oats	12.5	2.53	1.15	36.2	8.9	0.28	0.21
Silage							
Mixed Cereal	64.4	2.64	1.20	35.8	9.3	0.39	0.25
Barley	63.1	2.64	1.20	34.6	10.1	0.44	0.27
Oats	66.2	2.53	1.15	37.2	9.2	0.35	0.23
Corn	70.3	2.86	1.30	31.3	9.4	0.37	0.22
Alfalfa-grass	60.3	2.42	1.10	40.8	13.8	1.32	0.21
Grass (unspecified)	62.8	2.16	0.98	40.7	11.6	0.84	0.22
Legume-grass	66.5	2.31	1.05	44.1	12.8	1.12	0.21
Straw							
Barley	9.0	2.05	0.93	46.3	4.6	0.31	0.10
Oats	10.1	2.16	0.98	45.9	4.3	0.24	0.10
Wheat	8.9	1.80	0.82	49.6	4.0	0.21	0.08
Grains							
Barley	12.0	3.65	1.66		12.1	0.05	0.39
Oats	10.7	3.34	1.52		11.3	0.07	0.35
Wheat	12.3	3.87	1.76		15.6	0.04	0.40
Supplements							
Canola Meal	10.0	3.04	1.38		41.1	0.75	1.52
Soybean Meal (48%)	11.0	3.56	1.62		54.0	0.36	0.75
Dehy Alfalfa	8.0	2.68	1.22	31.5	18.5	1.52	0.22
32% Supplement	10.0	2.68	1.22	15.6	35.6	3.33 – 7.20	0.67 – 1.33
Urea					281.0		

Note: (1) All values except moisture are reported on a moisture-free basis

(2) Value (as fed) = Value (Moisture-free) $\times \frac{(100 - \%\ \text{Moisture})}{100}$

The level at which each nutrient is required by an animal will depend on whether the animal is being fed for maintenance, maintenance plus production or maintenance plus production plus reproduction. Most nutrients can be fed in excess of requirements, but if any nutrient is present in an inadequate amount, it will limit the performance.

performance in the herd, immediately or at a later date. This lowered performance will be reflected in the number of calves born and the interval between calvings.

The producer must provide enough feed during the winter season to meet the herd's requirements without providing so much feed that the cost of production rises to an uneconomical level. The best way to solve this dilemma is to supply the animals with a balanced ration that will give them sufficient nutrients to promote optimum efficiency in performance at a reasonable cost.

Nutrients

Adequate nutrition means providing the animal with specific levels of the nutrients required for maintenance, production and reproduction. These nutrients should supply the animal with energy, protein, minerals, vitamins and water.

Nutrients are found in varying amounts in all feedstuffs. Table 28 is a listing of some of the feeds commonly used in cow-calf operations along with the nutrient levels contained in them. It must be noted that the values listed are *average* values. Few feeds will contain exactly these levels of nutrients, so rations calculated using these levels will only be *approximations*. Specific nutrient levels for particular feeds being used can be obtained by sending samples to a feed testing laboratory for analysis.

The level at which each nutrient is required by an animal will depend on whether the animal is being fed for maintenance, maintenance plus production or maintenance plus production plus reproduction. Most nutrients can be fed in excess of requirements, but if any nutrient is not present in an adequate amount, the performance of the animal will be limited. This "principle of the first limiting nutrient" is illustrated in figure 19. In the example all but one of the nutrients are supplied in amounts adequate for a daily gain of one kilogram or more. Energy, however, is supplied at a level adequate for a daily gain of approximately 0.5 kilograms. The daily gain which will be achieved by an animal on this ration is about 0.5 kilograms. The performance, therefore, is determined by the "first limiting nutrient", in this example energy.

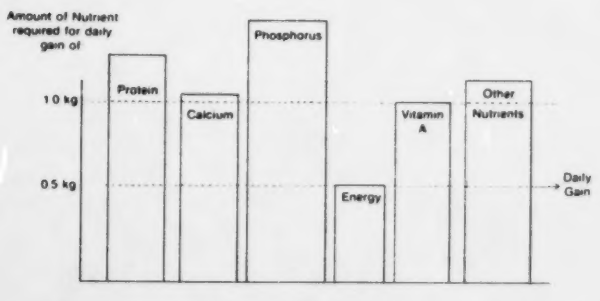


Figure 19 - Principle of the first limiting nutrient

Energy

Energy is usually the most limiting nutrient in a ration. It is the "fuel" that an animal "burns" for maintenance of body functions, for movement, for heat production in winter and for other productive purposes.

Ruminants obtain energy primarily from the fibre, carbohydrate and fat portions of a ration. Carbohydrates and fibre are fermented in the rumen. During this fermentation, rumen microorganisms increase in numbers and volatile fatty acids (acetic, propionic and butyric) are formed. These volatile fatty acids constitute the major source of energy for the ruminant. This system of digestion is unique to ruminants. Monogastrics (animals with a single stomach) utilize their food without the intervention and assistance of a microbial population.

The energy content of feed is calculated and expressed in a number of different forms. It is most often calculated for beef cattle as a unit of heat expressed in megacalories (Mcal). The different expressions of energy that exist are: gross or total energy (GE), digestible energy (DE), metabolizable energy (ME) and net energy (NE). The relationships between these different forms are illustrated in figure 20.

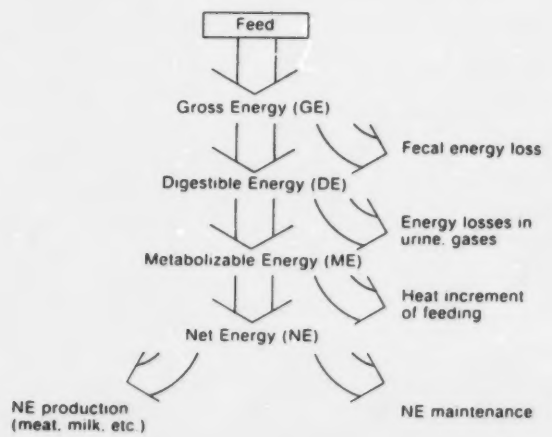


Figure 20 - The partition of energy

The most commonly used term for energy in ration formulation is digestible energy. It gives an indication of the actual amount of energy that the animal has available for use. The net energy system of calculation is becoming a popular method for use in ration formulation. However, it was developed under California conditions and does not appear to be completely applicable to Alberta, where more stressful climatic conditions occur.

A deficiency of energy caused by underfeeding is the most common nutritional problem in Alberta beef herds. It will cause a reduction in or cessation of growth, loss of weight, failure to conceive and increased mortality (often due to a lowered resistance to disease). Energy deficiencies are often complicated by deficiencies of protein or other nutrients.

Wiltbank demonstrated the effects that an energy deficiency can have on the reproductive performance of the beef cow. He showed that a deficiency in energy before calving can slow down the return of estrus (cows will be slow to show heat after calving), and a deficiency of energy after calving can lower conception rates (table 29).

Table 29
Effect of an energy deficiency on reproductive performance

Energy Level		% Which Showed Heat			
Before Calving	After Calving	Days After Calving			% Pregnant from 1st Service
		50	70	90	
High	High	65	90	95	67
Low	High	25	70	85	65
High	Low	76	86	86	42

Source: Wiltbank 1970

Another problem, overfeeding or supplying too much energy, is wasteful because it increases feed costs. It can also adversely affect reproductive performance by causing calving problems because of increased fat deposition around the reproductive tract, which reduces the area of the pelvic opening.

The energy value of forage is dependent on species and maturity. As forage becomes more mature the level of fibre increases and the energy content decreases. Voluntary intake of forage also decreases with increased maturity of the forage (table 30). When comparing hay that is cut early with hay that is cut late, one must remember the late-cut hay has less energy per kilogram and will be consumed at lower levels. Thus, animals fed poor quality hay on a free-choice basis may not consume enough energy to meet their requirements. Legumes are usually higher in energy than grasses when cut at similar maturity stages. Straws are comparatively high in fibre and low in energy.

Table 30
Feeding values of forages as influenced by stage of growth at harvest

	Digestible Energy	Crude Protein %		Intake
	(Mcal/kg)	Grass	Legume	% of bodyweight
Vegetative	2.77	15	21	3.0
Boot or bud	2.51	11	16	2.5
Bloom	2.20	7	11	2.0
Mature	1.94	4	7	1.5

Source: Fisher, L.J. 1980. Agassiz Agriculture Canada Research Station

Grains are concentrated sources of energy and are valuable as energy sources or supplements. Grains vary somewhat in energy content. Bushel weight is a reasonably good criterion with which to compare grains on an energy basis. For example, one kilogram of barley with a bushel weight of 16 kg (36 lb) per bushel contains about 93 per cent of the digestible energy contained in 1 kg of barley with a bushel weight of 22 kg (46 lb). The difference in energy on a weight basis might be considered as minimal, but the difference on a volume basis is great.

Protein

Proteins are composed of amino acids, which are nitrogen-containing compounds. Muscle, skin, hair, hooves and many other tissues and fluids in the body contain protein.

In the rumen most of the protein in the feed is broken down by the microbes to ammonia and carbon compounds. The microbes then use the ammonia to synthesize their own body protein. As feed is washed out of the rumen into the rest of the digestive tract the microorganisms are washed along too. The ruminant obtains most of its protein by digesting the microorganisms. This process of breakdown and re-synthesis of protein in the rumen allows the ruminant to make use of nonprotein nitrogen (NPN) sources such as urea. Such compounds are broken down to ammonia and carbon dioxide (as is whole protein) and used by the microbes to build their own body protein. Assuming there is sufficient energy present in the feed to allow the reactions to take place, ruminants are able to use nonprotein nitrogen sources nearly as efficiently as a conventional good quality protein source such as soybean meal.

A portion of the protein fed to the animal passes through the rumen without being degraded to ammonia and carbon compounds. This protein is available for digestion and absorption in the small intestine. This portion of the protein is commonly called by-pass protein. Most classes of beef cattle can meet their needs for protein from the microbial protein produced in the rumen and digested and

absorbed in the small intestine. However, cattle with high protein needs such as rapidly growing young calves and superior milk producing cows may require some by-pass protein, in addition to the microbial protein, to meet their protein needs. Most feedstuffs produce some by-pass protein. The amount supplied depends upon the kind of feedstuff and the physical or chemical treatments that the feedstuff has received.

The primary symptom of a protein deficiency is a depressed appetite. A reduced feed intake can cause an inadequate level of energy intake; therefore, protein deficiencies are often accompanied by energy deficiencies. Symptoms of protein deficiency and the resulting energy deficiency are irregular or delayed estrus (heat) in breeding females, loss of weight, slow growth and reduced milk production.

The levels of protein in roughages decrease as the forage becomes more mature (table 30). Green leafy roughages contain more protein than mature roughages; legumes contain higher levels of protein than grasses.

The protein content of grains varies with geographical area, level of nitrogen in the soil and weather conditions.

Minerals

The minerals required by cattle can be divided into two groups:

- Macro-minerals - those required in fairly large amounts.
- Micro-minerals or trace minerals - those required in smaller amounts.

At least 19 minerals are required by ruminants in greater or lesser amounts. Many of these minerals normally occur in sufficient quantities in feeds while others must be supplemented in the ruminant ration.

Macrominerals

Calcium (Ca)

Most of the body's calcium is found in the skeleton. Here calcium forms the bone matrix to allow for the rigidity of the body, protection of soft tissues and attachment for the muscles. Calcium is also needed by the body for blood clotting, nerve and muscle control, acid-base balance and for products such as milk.

Calcium is found in most feeds. Hays, especially legume hays, contain high levels of calcium. Grains, on the other hand, contain very low levels of calcium. Other sources of calcium include mineral supplements such as bonemeal, ground limestone, dicalcium phosphate and defluorinated rock phosphate.

In ruminants, calcium deficiencies often result when animals are fed high grain rations without proper calcium supplementation. Calcium deficiencies will cause rickets in young animals and osteomalacia in mature animals. Rickets is a nutritional disease in which the bones fail to harden properly and, therefore, bend or break easily and cause stiffness in the animal. Osteomalacia is a condition that results from the withdrawal of calcium from the bones in a period of deficiency. It cause bones to break easily and milk production levels to decline. High levels of phosphorus or low levels of Vitamin D may also cause apparent calcium deficiencies.

Calcium is a very important mineral in ruminant nutrition: a calcium supplement should be fed to cattle if grain is the major feedstuff in the ration.

Phosphorus (P)

Phosphorus, like calcium, is found mainly in the bones of the body. Phosphorus is also used in the metabolism of energy, in acid-base balance and in the body's enzyme systems. Phosphorus levels in grains are relatively high, while levels in roughages are normally lower. Other phosphorus sources are bonemeal, dicalcium phosphate and defluorinated rock phosphate.

A phosphorus deficiency is characterized by poor reproductive performance, as seen by irregular estrus (heat cycle) and reduced fertility (table 31). A deficiency in phosphorus can also be evidenced by stiffness in the hindquarters, bones that are easily broken, rickets or pica (a depraved appetite where animals chew and eat rocks, dirt, wood, bones, etc.)

In two research trials (table 31) supplementing phosphorus with bone meal resulted in a higher percentage of calves weaned and a shorter period between calvings.

Table 31
Phosphorus effect on reproductive performance

	No Phosphorus	Bonemeal
No. of Cows	168	168
Calf Crop Weaned (%)	64	88
Average No. of Days Between Calvings	459	365
Texas:		
No. of Cows	40	143
Cows Calving (%)	64	85
Calf Crop Weaned (%)	58	81

Source: Wiltbank 1970

In a cow-calf operation, where the main feeds are roughages, a phosphorus supplement should be available free-choice at all times unless the manager is certain the feeds are supplying sufficient phosphorus.

Calcium-phosphorus ratio

An imbalance in the levels of calcium and phosphorus can be as bad as a deficiency of either

mineral. Too high a level of phosphorus can tie up the calcium present and cause deficiency in calcium. Calcium levels that are too high can lower the availability of phosphorus and cause an apparent phosphorus deficiency. For ruminants, the calcium:phosphorus ratio should be not less than 1:1 (equal parts of calcium and phosphorus) nor greater than 7:1 (7 parts of calcium to 1 part of phosphorus). Some recent information suggests that a calcium: phosphorus ratio of 1.75:1 to 2:1 may be necessary for cattle on high grain rations to make the best use of the starch in grain. A low calcium level can cause the pH of the small intestine to be too low for optimum digestion and absorption of starch.

Calcium-phosphorus mineral supplements

The type of mineral supplement to use will depend on the feedstuffs consumed by the cattle. Cattle on a legume forage diet should be supplemented with a mineral mixture containing equal amounts of calcium and phosphorus and at least 14 per cent phosphorus. This type of mineral is commonly referred to as 1 to 1 mineral. Minerals containing phosphorus but no calcium can also be used with legumes. However, these minerals are generally less palatable than 1 to 1 minerals. If consumption of a mineral containing no calcium is poor, another type of mineral should be used.

Cattle grazing mainly grass pasture or receiving either hay or silage should be supplemented with a mineral mixture containing about twice as much calcium as phosphorus and at least 8 per cent phosphorus. A mineral of this type is commonly called a 2 to 1 mineral. However, a 1 to 1 mineral can also be used for cattle on a grass diet. Generally, 2 to 1 minerals are more palatable than 1 to 1 minerals.

If cattle are fed cereal silage or greenfeed or are grazing stubble aftermath, they should be supplemented with a 2 to 1 mineral.

Free choice consumption of mineral supplements is often erratic. Studies have shown that cattle have little nutritional wisdom and usually fail to eat the proper mineral supplement in sufficient quantities to balance their diet. The exception to this observation is that cattle will likely consume enough salt, on a free choice basis, to meet their needs. In fact, mixing salt with other mineral supplements usually increases palatability and improves overall mineral intake. A free choice salt/mineral mixture should be 40-60 per cent mineral supplement if a significant level of supplementation is to be achieved. Even with these proportions of salt and mineral, there are definite limits to the amount of mineral supplementation that can be achieved with a free choice system.

Often, cattle on pasture are able to consume enough mineral supplement if the salt mineral mix is supplied in the loose form in a location that is convenient for the cattle.

It is important to remember that the amount of phosphorus required by cows increases dramatically after calving. A considerable amount of phosphorus is in the milk. As a result, the phosphorus requirement of heavier milking cows is higher than that of average producing cows. Cows that are fed mainly on roughage will require considerable amounts of supplemental phosphorus after calving.

Table 32
18:18 mineral recommended to supplement the phosphorus supplied by an alfalfa-grass hay ration[a]

	Grams	Ounces
Wintering	15	0.5
Late gestation	15	0.5
Average milker	70	2.5
Superior milker	140	5.0

[a] for a 500 kg (1100 lb) cow

It is doubtful that cows will consume enough phosphorus on a free-choice basis to meet their needs after calving. It may be necessary to feed cows some grain with minerals added between the time of calving and the time they move to good green pasture. The energy supplied by the grain will help to meet the cow's increased energy needs at this time as well. If 2.5 kg (5.5 lb) of grain is fed per head per day, include 10 kg (22 lb) of a 1 to 1 mineral in each tonne of grain if average milking cows are being fed. If superior milking cows are being fed, add 30 kg (66 lb) of mineral in each tonne of grain. In addition, the salt mineral mix should also be available free-choice.

Magnesium (Mg)

Magnesium plays a part in the cow's carbohydrate metabolism and enzyme systems involved in the transfer of energy.

Normally feeds contain sufficient amounts of magnesium to meet an animal's requirements, but certain conditions can cause a lowered availability of magnesium. For example, animals placed on a lush green pasture may, in some cases, be affected by grass tetany, the most common type of magnesium deficiency.

The condition usually occurs five to ten days after cattle are turned out on pasture. It occurs most often in older cows and cows in their first two months of lactation. Tetany can also be a problem in winter or early spring when cows are exposed to bad weather.

Symptoms of tetany are: unusual alertness and nervousness; muscle twitching; staggering gait, falling; convulsions; less acute forms show up as a loss of appetite and a stiffness in gait.

Magnesium supplementation is difficult on pasture unless grain is fed daily. The palatability of magnesium oxide is poor, so including magnesium supplements in free choice mineral mixes is

often ineffective. Grass tetany is caused by a lowered availability of magnesium and not necessarily a dietary deficiency. The precise causes of tetany are often difficult to ascertain.

Potassium (K)

Potassium, like sodium, serves to maintain proper acidity levels of body fluids and osmotic pressure in cells. It is also required for a number of enzyme reactions in carbohydrate metabolism and protein synthesis. Forages normally contain more than adequate amounts of potassium. Supplemental potassium may be necessary for high-grain feedlot diets.

Sodium (Na) & Chlorine (Cl)

These minerals are found together as common salt. They function in the acid-base and osmotic pressure balance in the body. Chlorine also forms part of the digestive juices in the abomasum.

There is no reason for a deficiency of salt to occur. Salt is relatively inexpensive and very palatable. Cattle will go looking for it if they do not get enough.

Salt can be fed either free-choice or as part of the ration. Under ordinary circumstances the use of salt licks or rations containing the usual 0.25 per cent to 0.50 per cent salt will be perfectly safe. Excessive salt consumption may occur if animals are offered loose salt after being without salt for a considerable length of time. One should avoid the use of salt-control rations when animals have restricted access to water.

Excessive salt consumption may cause death by upsetting the tissue water balance by impairing the ability of the kidneys to remove excess water from the blood stream. Symptoms include salivation, thirst, muscular spasms, scouring and prostration.

Trace minerals

Iodine (I) -Cobalt (Co)

Cobalt and iodine are required in very small amounts but nonetheless are essential in the rations of ruminants. Iodine is used in the control of the animal's metabolic rate. Cobalt is needed by the rumen microbes to produce the vitamin B12 required by the animal.

A deficiency of iodine can cause goiter and the birth of hairless calves. A cobalt deficiency results in a loss of appetite and an anemic, listless, emaciated animal. Animals with a cobalt deficiency show symptoms of starvation, in spite of the fact that feed is plentiful.

Selenium (Se)

Selenium is deficient in some regions of the province and surplus in others. Alkali disease or blind staggers occurs when cattle eat feed containing toxic or excess amounts of Se (2 mg/kg) over a long period of time. Chronic toxicity results in loss of weight, dullness, sloughing of hooves and lameness. Toxicity is rare but occasionally found where cattle on overgrazed pasture in the Brown Soil zone are forced to eat a milkvetch, *Astragalus* Sp., that accumulates selenium. The best cure in this case is to remove the animal from the pasture.

Selenium deficiency is much more prevalent and may result in white muscle disease in calves. A vitamin E deficiency increases the amount of selenium required to prevent this form of nutritional muscular dystrophy. Cows on Se deficient diets may have a lower fertility and an increased incidence of retained placentas. The minimum daily requirement of Se is at least 200 parts per billion (0.2 mg/kg).

Selenium deficiencies have been observed in many parts of the province. However, based on the results of the feeds tested for selenium at the Agricultural Soils and Animal Nutrition Laboratory, and information from producers and industry, we know that selenium deficiency is more of a problem in those areas of Alberta west of Highway 2 or north of Highway 16 than in other parts of the province. If selenium deficiency is a problem, supplemental selenium should be provided in the ration.

Supplemental selenium can be purchased in complete feeds and in salt, mineral or injectible form. When injectible selenium is used, injections are needed at monthly intervals.

Iron (Fe)

Iron is an essential part of hemoglobin, a compound that carries oxygen in the blood. A deficiency of iron may cause anemia and reduce growth. There is generally no need to supply extra iron since virtually all feeds in Alberta contain enough iron for cattle.

Zinc (Zn)

Zinc affects growth rate, reproduction, skeletal development, skin condition and the utilization of protein, carbohydrates and fats in the body. The classical symptom of a severe deficiency is a mange-like skin condition called parakeratosis. While the incidence of this condition is rare in Alberta, the incidence of reduced growth rates as a result of low zinc levels appears to be increasing in the province.

Dietary requirements are about 50 mg/kg while the average concentration in forage samples analyzed at the Agricultural Soils and Animal Nutrition Laboratory (ASANL) in the past few years is about 25 mg/kg. If a supplement is required, it can be supplied in trace mineralized salt or in some mineral or protein supplements.

Copper (Cu)

A copper deficiency can result in anemia, depigmentation in hair, rough hair coat, stunted growth, loss of condition, depraved appetite, infertility in cows, diarrhea and cardiac failure. Most of the feeds tested for copper at ASANL in the

past few years contained less than the estimated daily requirement of 10 ppm. The incidence of copper deficiency also appears to be increasing. Copper can be supplemented with trace mineral salts, mineral supplements or protein supplements.

Molybdenum (Mo)

Molybdenum forms an essential part of some enzymes. It may also have a stimulating effect on fibre digesting microorganisms in the rumen.

Excessive quantities of Mo interfere with the utilization of copper and may a cause copper deficiency. Symptoms of copper deficiency include severe scours and loss of body weight. High sulphur levels can also interfere with copper utilization. A high sulphur content in the diet or water supply can therefore make a problem with excess molybdenum more severe.

The level of molybdenum in Alberta feeds is low. Molybdenum induced copper deficiency does not appear to be a problem in Alberta.

Manganese (Mn)

Manganese is essential for the utilization of carbohydrates. Reproductive disorders in the adult cow are among the early symptoms of a deficiency. These include delayed estrus, reduced fertility, abortions and deformed calves. Calves born to manganese-deficient cows have deformed legs (over-knuckling, enlarged joints, stiffness, and twisted legs), weak and shortened bones and poor growth.

Manganese deficiency occurs occasionally within the province. However, most of the forages analyzed for manganese at ASANL in recent years contained more than 40 ppm, the minimum requirement.

Other trace minerals

Chromium (Cr), tin (Sn) and nickel (Ni) appear to be present in sufficient quantities in Alberta feeds to meet the requirements of most farm animals.

Flourine (Fl) is essential for proper bone development but will cause toxicity if fed at too high a rate. It is used in domestic water supplies to reduce the incidence of tooth decay. Too much fluorine causes abnormal bone growth, mottling and degeneration of teeth and delayed growth and reproduction. To avoid excessive consumption of Fl, be sure that rock phosphate feed is defluorinated.

When to supplement with trace minerals

There is increasing evidence that some parts of Alberta are experiencing production losses as a result of trace minaral deficiencies. These deficiencies are beginning to appear and be recognized on land that has been farmed for many years, especially when high yielding crops are produced.

Iodine and cobalt have been recognized as deficient in many parts of Alberta for many years. In the past 15 to 20 years selenium deficiency has become a major problem in many parts of the province. Copper, manganese and zinc levels in feeds are commonly below published requirement levels for beef cattle. Improvements in animal health, growth and reproduction have often been observed when these trace minerals are given as supplements in the diet of beef cattle. It is now accepted by most livestock specialists in Alberta that routine trace mineral supplementation is well worth the small cost.

A convenient and relatively inexpensive method of supplementing the commonly deficient trace minerals is to provide a trace mineralized salt on a free choice basis all year long. Many different types of trace mineral salts are available, but to provide meaningful supplementation of most Alberta feeds, the formulation in table 33 is recommended.

Table 33
Recommended trace mineral levels in salt for Alberta beef cattle

Mineral	Level req'd in the salt mg/kg	Percent of a beef cow's total daily requirements requirements provided by 30 g of salt
Copper	2000-3000	60- 90
Manganese	5000-8500	30- 38
Zinc	5000-12000	42- 72
Iodine	70-200	42- 60
Cobalt	30-60	90-120
Selenium	25-75 [a]	38-113

[a] The maximum allowable level of selenium in a registered trace mineral salt is 25 mg/kg. This amount is sufficient only to overcome borderline deficiencies. A higher level of selenium is recommended in the trace mineral salt whenever the feeds contain selenium at less than 100 parts per billion. Custom formulations requiring prescriptions written by a veterinarian are available to provide meaningful supplementation of selenium in these cases.

Although trace mineral supplementation is routinely recommended for beef cattle in Alberta, the importance of major nutrients such as energy, protein, calcium and phosphorus should not be forgotten. Deficiencies of these nutrients are much more common and costly to the producer than are trace mineral problems. Care should always be taken to ensure that label directions are followed especially for highly concentrated premixes.

Remember that trace minerals are required in very minute amounts and that some trace minerals can be toxic at levels just 10 times higher than the required amounts.

Vitamins

These organic compounds are required in minute amounts by the body. They are essential to metabolism and some must be supplied in the feed of ruminants.

The vitamins normally required by cattle are vitamin A, D and E. The rest of the vitamins (B-vitamins and vitamin K) are produced by rumen microorganisms in sufficient quantities so that additional supplements are usually not beneficial (see section on cobalt).

Vitamins A, D and E or their precursors occur naturally in many feeds. In the summer months, when cattle are on fresh pasture, these vitamins are present in sufficient quantities so that synthetic supplements are not required. However, in the winter months it is advisable to use synthetic sources of these vitamins. The synthetic vitamins are relatively inexpensive safeguards against deficiencies. Also the vitamin content in cured feeds may be very low or unavailable for use by the cattle.

Vitamin A

Vitamin A is the most important vitamin in cattle nutrition. It is the only one which normally *must be added* to cattle diets. It is necessary for bone development, sight and maintenance of healthy epithelial (skin) tissues. A deficiency can cause an increased susceptibility to disease, night blindness and reproductive failure.

Vitamin A may be supplied by green forages which contain carotenoids. Carotenoids are broken down in the body to form vitamin A. Thus forages are not analyzed for vitamin A but for carotenoids, which are measured in milligrams per kilogram or pound: mg/kg or mg/lb.

Cattle can convert 1 mg of carotene to 400 international units (IU) of vitamin A, while chickens can convert 1 mg to 1667 IU of vitamin A. Animals on green grass can store vitamin A in the liver and draw on it for 2-3 months.

The average carotene value of alfalfa hay is 54.1 mg/kg (24.6 mg/lb), but the range of vitamin A equivalent values supplied by alfalfa can vary from 265 IU to 77,880 IU per kg (120 IU to 35,400 IU per lb). Although Alberta forages may contain sufficient carotene to meet all requirements, it is good insurance to feed vitamin A, since the carotene content of a forage declines in storage. Vitamin A is inexpensive. The dry granular product is the most economical source. Alternatively, animals may be injected with a two to three month supply. It should be injected twice during the winter.

Water soluble vitamin A is sometimes added to the water, but it is difficult to tell whether the animal is getting its daily or monthly quota this way. Most mineral supplements cannot routinely be relied upon to supply enough vitamin A. Check the label for vitamin A concentration and calculate how much mineral needs to be consumed to meet the daily requirements for livestock.

Vitamin D

Vitamin D is called the sunshine vitamin because ultraviolet light acting on a compound in an animal's skin changes that compound into vitamin D. Vitamin D is found in sun-cured forages. Animals kept outdoors or fed sun-cured hay do not usually suffer a deficiency, whereas animals kept indoors and fed silage may do so.

Because vitamin D is involved in the uptake of Ca and P, a vitamin D deficiency resembles a Ca and P deficiency: rickets in the young animal, weak bones in older animals and a decreased growth rate.

Vitamin E

Vitamin E and selenium have similar and interrelated functions in the body. Use supplements containing vitamins D and E in addition to vitamin A. They may not always be necessary but cost little to add.

Water

Water is also an important nutrient in beef cattle nutrition. A restriction in water intake can greatly reduce feed intake. For this reason, water should be available on an *ad libitum* (free-choice) basis at all times.

Water quality is also important to livestock. It should be free from fecal contamination or algal toxins, and contain less than 100 ppm nitrates. A total salts content of not more than 7,000 ppm can be tolerated by young animals, while older cattle will tolerate up to 10,000 ppm.

Table 34
Minimum daily nutrient requirements of several classes of beef cattle

Class of animal	Weight kg	Weight lb	Expected daily gain kg	Expected daily gain lb	Estimated feed intake (90% dry matter basis) kg	Estimated feed intake (90% dry matter basis) lb	Digestible energy Mcal	Crude protein kg	Crude protein lb	Calcium kg	Calcium lb	Phosphorous g	Phosphorous lb	Vitamin A IU
Growing steer or heifer	225	495	.45	1.00	5.9	13	14.0	.58	1.27	18	.040	15	.032	20,000
Growing steer or heifer	225	495	.70	1.54	6.4	14	15.5	.65	1.42	18	.040	15	.032	20,000
Finishing steer	365	803	1.36	3.00	10.0	22	29.8	.97	2.14	31	.068	23	.050	40,000
Finishing steer	450	990	1.36	3.00	11.4	25	35.3	1.08	2.37	37	.081	27	.060	40,000
Bred heifer	425	935	.40	.88	9.1	20	22.0	.75	1.65	30	.065	21	.046	40,000
Wintering pregnant cow	500	1100	.23	.50	10.0	22	19.2	.59	1.30	20	.045	17	.037	40,000
Late gestation cow	500	1100	.23	.50	10.9	24	22.1	.68	1.50	25	.055	20	.044	60,000
Nursing cow (5 kg milk)	500	1100	.20	.44	12.3	27	25.6	.91	2.00	32	.070	26	.057	60,000
Nusing cow (10 kg milk)	500	1100	.20	.44	15.0	33	32.2	1.27	2.80	46	.102	34	.075	70,000
Growing bull	500	1200	.70	1.54	12.7	28	30.0	1.07	2.35	32	.007	23	.051	60,000
Mature bull	800	1760	—	—	14.1	31	30.0	1.00	2.20	33	.073	24	.053	60,000
Mature bull	800	1760	.70	1.54	16.0	35	40.0	1.32	2.90	59	.130	34	.075	70,000

Nutrient requirements

Different groups of livestock have different requirements for all the nutrients. In a cow-calf operation, the levels of the various nutrients required will depend on whether you are feeding for maintenance, maintenance plus production, or maintenance plus reproduction. The first requirement, that of maintenance, is defined as the amount of feed that must be fed to keep an animal at a particular weight without any significant change in body composition. The maintenance requirement is that amount of feed needed to maintain essential body functions such as respiration, heart rate, eating, keeping warm, etc. It also includes the feed needed to replace the nutrients that are excreted daily from the body. Tissues of the body are constantly undergoing breakdown and repair and, therefore, nutrients are required to replace the proteins and minerals lost. The maintenance requirements of an animal must be met first before any production or reproduction can occur. If we picture an animal as a barrel into which we are pouring feed, the relationship between maintenance, production and reproduction can be more easily seen (figure 21).

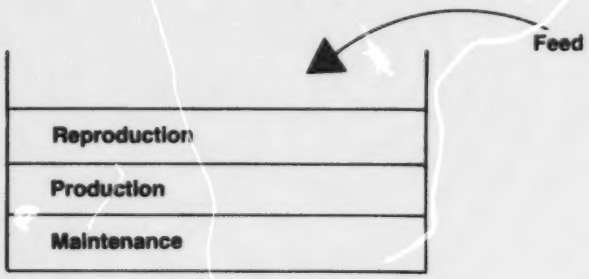


Figure 21. Relationship between maintenance and production

It is obvious that the bottom of the barrel must be filled first. There are specific maintenance requirements for each of the essential nutrients. Requirements for production are the next to be met. These are the amounts of feed needed for growth or milk production. Large quantities of feed may be needed to meet these requirements. A lactating cow may need about double the energy and protein that a dry cow needs. A growing calf needs much higher concentrations of protein and energy than a mature cow.

The requirements for reproduction are very important in a cow-calf operation. Since cows are pregnant for 75 per cent of the year, usually during the time of most expensive feed costs, the producer must be concerned with the requirements for reproduction. These requirements are the amounts of feed needed, above that for maintenance, for the cow to conceive and produce a healthy fetus and calf. Reproduction means increased requirements for proteins and minerals to build the body of the fetus, plus energy and vitamins to utilize them.

Although requirements for production and reproduction are shown as being separate in the illustration, they can in fact be closely related. Some cows in a herd may reduce milk production and rebreed if the amounts of some nutrients supplied are borderline, while other cows may respond in the opposite way.

The various factors that will determine the level of nutrients required by an animal can be summarized as follows:

- species or breed
- age and sex
- the nature and level of production
- the level at which and the chemical form in which a nutrient is fed
- the overall balance of nutrients
- hormonal and physiological activities in the animal
- stress from the environment.

All these factors must be considered when formulating rations for the cow-calf operation. In cow-calf nutrition the object is to formulate balanced rations that supply all the required nutrients at adequate levels, in a proper balance and at minimum cost.

Feed intake

Beef cattle will consume feed (moisture-free basis) at the rate of 1.4 to 2.7 per cent of their body weight. Feed consumption will vary depending on the ration's concentrate-roughage ratio and on the age and condition of the animal. Older and more fleshy cattle will consume less feed per unit of body weight than will younger, leaner animals.

An approximation of the voluntary feed intakes for different types of feeds by cattle is contained in table 35. The use of these figures, along with some common sense as to practical management, can help the producer formulate rations that are within the ability of the animal to consume.

Table 35
Consumption estimates of common feeds[a]

Feedstuff	Daily consumption as per cent of body weight
Excellent quality hay	3
Very good quality hay	2.5
Medium quality hay	2
Poor hay, oat straw or barley straw	1.5
Wheat straw	1
Silage (air dry basis)	2 - 3
Oats	3
Barley	2.5
Wheat	1.5 - 2

[a] 90% dry matter basis

Winter feeding programs for cows and bred heifers

The condition of cows going into winter has a major effect on the amount and quality of feed they will need. Cows in thin condition in the fall must gain weight throughout the winter. As a result, they must be fed good quality roughage, or an average quality roughage and some grain. Cows that are in good condition in early winter need only enough feed to maintain their weight until calving. In this case poor quality hay or good straw can be the major component of the feeding program. If cows are in good condition in early winter, good quality straw can be use for as much as 75 per cent of the cows' diet until about six weeks before calving.

Straw can be fed in conjunction with medium to good quality hay, grain, protein supplement or combinations of these materials. Straw is only slightly lower in energy than average quality hay, but is usually low in protein, minerals and vitamins. As a result, additional quantities of these nutrients must be provided. In most cases grain or high quality hay will supply the additional energy needed.

Whenever cows are fed on low quality diets, such as straw or poor quality hay, or the amount of feed offered is closely controlled, good management of the herd becomes more critical. In these situations it is important to know the exact quality of the feeds being used. Feed testing and proper application of the feed test results become increasingly important.

It is often beneficial to divide the cow herd into two or three different groups for winter feeding. The first group should be the young mature cows in good condition. They need the least amount of care to get them through the winter in good condition.

The second group should include heifers that will calve for the first or second time. They are young growing animals that cannot compete effectively for feed with the mature cows unless all the cows are considerably overfed. They also need either a better quality hay or more supplemental grain than mature cows.

The third group should be made up of thin and old cows. Again, they have trouble competing with the more aggressive mature cows in better condition. These cows also need additional feed to get them through the winter. If your cows cannot be handled in three groups, combine the heifers and the old thin cows in one group. It might be wise to send some of the old thin cows to slaughter.

Most winter feeding programs for cows require supplemental minerals and salt. Trace mineralized salt should be available on a free-choice basis. In addition, rations based largely on hay should be supplemented by having a mineral supplement containing equal parts of calcium and phosphorus available on a free-choice basis. Rations based on greenfeed, cereal silage, straw and grain should be supplemented, on a free-choice basis, with a mineral containing two parts of calcium and one part of phosphorus. The amount of mineral consumed should be 15 to 30 grams per head per day. Mix salt with the minerals in order to get the cows to consume enough.

A beef cow requires 40,000 IU of vitamin A daily before calving. After she calves, but before she has access to green grass, she needs 60,000 to 70,000 IU of vitamin A daily. The higher amount is needed by superior milking cows. Vitamin A is stored in the liver and is used when needed. It can be fed: daily, at 2 or 3 week intervals, at 1 or 2 month intervals. Also, a sufficient supply can be injected every 2 or 3 months. The important thing to remember is that enough vitamin A must be supplied to meet the cow's daily requirement. If the cow is given vitamin A once a month, she must receive a 30-day supply at that time.

The sample rations which follow are designed to meet the needs of a 500 kg (1100 lb) mature pregnant beef cow gaining 0.25 kg (0.5 lb) per day under normal winter conditions in Alberta.

The following rations are based on the average nutrient content of Alberta feeds. These rations should contain adequate amounts of energy and protein, but will require mineral and vitamin supplementation. An analysis of your feeds is recommended so you can accurately adapt these rations to your situation.

Ration No. 1
10 kg (22 lb) grass hay

Ration No. 2
9 kg (19.8 lb) alfalfa-brome hay (50:50)

Ration No. 3
6 kg (13.2 lb) good quality barley or oat straw
3.6 kg (7.9 lb) good quality alfalfa

Ration No. 4
7.5 kg (16.5 lb) good quality barley or oat straw
1.5 kg (3.3 lb) oats or barley grain
0.5 kg (1.1 lb) 32% protein supplement

Ration No. 5
4 kg (8.8 lb) grass hay
4 kg (8.8 lb) good quality barley or oat straw
1.5 kg (3.3 lb) oats or barley grain
Ration No. 6
8.5 kg (18.7 lb) good quality greenfeed
Ration No. 7
22 kg (48 lb) cereal silage (65% moisture)

These rations do not make allowance for wastage by cows. The amount of feed offered to cows should be increased to make up for the amount of feed they waste. Although these rations make some allowance for cold weather, under very cold conditions additional feed will be required to meet the cows' needs for energy. For every 10°C that the mid-day temperature is below -20°C an additional 3 kg (6.6 lb) of hay, 6.2 kg (13.7 lb) of silage or 2 kg (4.4 lb) of grain should be fed depending on the type of ration being used.

The thin and old cows in the herd will likely weigh 50 kg (110 lb) to 100 kg (220 lb) less than the young mature cows in good condition. As a result these cows will have a lower maintenance requirement in normal winter conditions. However, thin cows have less fat for insulation against heat loss and very little energy in reserve to draw on. Under cold weather conditions they require special attention and should receive more feed than cows in good condition. The feed should be of good quality so that it will be readily consumed by the cows, and it should be offered in an area that is protected from the wind.

The bred heifers will have about the same daily requirement for nutrients as the young mature cows. Since heifers are smaller than mature cows, they cannot consume as much poor quality feed; however, they should be able to consume the quantity of alfalfa-grass hay, greenfeed or cereal silage suggested for mature cows. For the straw-grain diets an additional 1.5 kg (3.3 lb) of grain should be fed. Straw consumption is likely to decrease by about 2.5 kg (5.5 lb). Another possible ration would be 7 kg (15.4 lb) of grass hay and 2 kg (4.4 lb) of grain.

During the last six weeks to two months before calving the amount of nutrients supplied in a ration should be increased by about 15 per cent. This can be accomplished either by feeding more of the wintering ration or by substituting some good quality feed for some of the low quality feeds used in the ration.

Post-calving feeding of cows

The cows' needs for nutrients increase substantially after calving. The requirements of superior milking cows increase more than that of average milking cows. Superior milking cows require about 60 per cent more energy, 115 per cent more protein and 85 per cent more phosphorus after calving than they required in the middle of winter. If the cows' requirements are not met, a cow may take longer to begin cycling, have weak or irregular estrus signs, have lower conception levels, and as a result may either not conceive or may conceive late in the breeding season. (see comments earlier in this section under "Nutrients"). Depending on when the cows are calving, they are normally fed stored feeds for all or part of the time between calving and rebreeding. This is the most critical time of the year for cows and often is a time of the year when their needs are neglected. Proper feeding at this time of the year will pay dividends in the next calving season. The best quality feeds should be saved for this time of the year.

The following rations will meet the energy and protein needs of a 500 kg (1100 lb) cow producing 5 kg (11 lb) of milk. These rations do not make allowance for wastage.
Ration No. 1
10 kg (22 lb) grass hay
1.8 kg (4 lb) oats or barley grain
Ration No. 2
12 kg (26.4 Ib) alfalfa-brome hay (50:50)
Ration No. 3
11 kg (24.2 lb) good quality alfalfa hay
Ration No. 4
27 kg (60 lb) cereal silage (65% moisture)
Ration No. 5
7 kg (15.4 lb) good quality oat or barley straw
3.2 kg (7.0 lb) oats or barley grain
1.0 kg (2.2 lb) 32% supplement

The following rations will meet the energy and protein needs of a 500 kg (1100 lb) cow producing 10 kg (22 lb) of milk. Again, no allowance has been made for wastage.
Ration No. 1
10 kg (22 lb) grass hay
2.8 kg (6.2 lb) oats or barley grain
0.7 kg (1.5 lb) 32% supplement
Ration No. 2
12 kg (26.4 lb) alfalfa-brome hay (50:50)
1.5 kg (3.3 lb) oats or barley grain
Ration No. 3
13.5 kg (29.7 lb) alfalfa hay
Ration No. 4
27 kg (60 lb) cereal silage (65% moisture)
1 kg (2.2 lb) oats or barley grain
0.8 kg (1.8 lb) 32% supplement

After calving, the cow's requirement for supplemental minerals increases from 60 to 150 grams per cow per day depending on the amount of milk the cow is producing and the type of feed being used. After calving a mineral supplement containing equal parts of calcium and phosphorus is the normal practice. If cows are fed grain at this time, the mineral should be mixed with the grain as cows usually will not consume a sufficient amount of mineral free-choice.

In addition, trace mineral salt should be fed on a free-choice basis. The vitamin A requirement after calving increases to 60,000 to 70,000 IU per head per day.

Winter feeding of replacement heifer calves

To be large enough to breed, heifers have to weigh from 315 kg (693 lb) to 350 kg (770 lb) at 14 to 15 months of age, depending on the breed. Heifers will have to gain at the rate of about 0.7 kg (1.5 lb) per day throughout the winter to reach that size. The rations for this rate of gain and the comments regarding mineral, salt and vitamin A in the section about growing calves also apply to replacement heifer calves.

Winter feeding of growing calves

In the past producers have used feeding programs designed to allow calves to gain at a rate of 0.5 to 0.8 kg (1.1 to 1.75 lb) per day. This sort of program is still appropriate for calves going back on grass the next summer, and for calves which must be grown-out before going on full feed in order that they reach acceptable slaughter weights before getting too fat.

Some producers now aim for a daily gain of 0.9 to 1.0 kg (2.0 to 2.2 lb). Large growthy calves, especially cross-bred calves from European breeds, have the ability to gain weight rapidly and still obtain acceptable slaughter weights while grading A1 or A2. If you are feeding British breeds of calves as bulls for slaughter, a high rate of gain should be aimed at.

A feeding program that produces rapid gains should only be used when the calves are going to remain in the feedlot until they go to slaughter. If the calves are to be marketed as feeder cattle, consider a program that will produce moderate gains, as most buyers of feeder cattle discount fleshy cattle.

Calves fed to gain 0.5 kg (1.1 lb) per day during the winter will gain weight more quickly on grass than calves whose winter rate gain was higher. Calves going to grass in the spring should be fed to gain only a modest amount of weight.

When deciding on a feeding program bear in mind that feed costs per kilogram or pound of gain generally decrease as the rate of gain increases. Check this by applying your feed costs to some of the rations given in the examples which follow.

If borrowed money is used, consider the cost of interest. If you borrowed $450 per calf purchased and the interest rate is 12 per cent per annum, the daily amount of interest on each calf will be about 15 cents. This cost is constant whether the calves gain 0.5 or 1.0 kg per day, and is a substantial additional cost that must be taken into account.

The probable selling price of your calves should also be considered when setting up a feeding program. Information on the market situation can be obtained from Alberta Agriculture, the Canadian Cattlemen's Association, the Alberta Cattle Commission, agribusiness and numerous other sources. If a feeding program needs to be modified to fit in with a change in expected selling date, the earlier you begin the better.

Some grain must be included in most rations for wintering calves. A protein supplement may be necessary if poor to medium quality forage are fed. Use the best quality forage available for calves; cows can maintain themselves on poor to medium quality roughage.

Vitamin A should be included in the calves' grain mix or injected every two or three months. Calves should receive 20,000 to 30,000 IU of vitamin A per day. The lower amount should be used for light calves and for feeding programs that aim at modest weight gains; use the higher level when rapid weight gains are expected, especially from heavy calves. Provided that the total amount of vitamin A meets the daily requirements, it can be fed daily, weekly, monthly or injected once every two or three months.

Most calf rations require mineral supplementation. The minerals should be mixed in the grain portion of the ration whenever possible. Minerals should also be offered free-choice. If the ration contains a considerable amount of legume forage, use a mineral supplement containing equal parts of calcium and phosphorus.

A ration based on a grass hay, greenfeed or cereal silage should be supplemented with a mineral containing two parts of calcium to one part of phosphorus. Any program using grain as two-thirds or more of the total ration should have 1 per cent ground limestone added to the grain mix. Trace mineralized salt should be available free-choice, or added to the grain mix.

The following sample rations have been calculated on the basis of "average" Alberta feeds and the minimum nutrient to take calves from 200 kg (440 lb) to 300 kg (660 lb) at a rate of 0.7 kg (1.5 lb) per day. It is assumed that no growth implants or feed additives are being used. Supplemental minerals, salt and vitamin A must be provided.

Ration No. 1
- 6 kg (13.2 lb) good quality alfalfa hay
- 0.7 kg (1.5 lb) barley grain

Ration No. 2
- 5 kg (11 lb) alfalfa-brome hay (50:50)
- 1.6 kg (3.5 lb) barley grain

Ration No. 3
- 5 kg (11 lb) greenfeed
- 0.9 kg (2.0 lb) barley grain
- 0.6 kg (1.32 lb) 32% protein supplement

Ration No. 4
- 12 kg (26.4 lb) cereal silage (65% moisture)
- 1.1 kg (2.4 lb) barley grain
- 0.5 kg (1.1 lb) 32% protein supplement

The following sample rations have been calculated on the basis of average Alberta feeds and the minimum nutrient requirements to take calves from 200 kg (440 lb) to 350 kg (770 lb) at the rate of 0.9 kg (2.0 lb) per day. It is assumed that no growth implants or feed additives are used. Supplemental minerals, salt and vitamin A must be provided as required.

Ration No. 1
5.5 kg (12.1 lb) good quality alfalfa hay
2.25 kg (5.0 lb) barley grain

Ration No. 2
5 kg (11 lb) alfalfa-brome hay (50:50)
2.8 kg (6.2 lb) barley grain

Ration No. 3
5 kg (11 lb) oats greenfeed
2.3 kg (5.1 lb) barley grain
0.4 kg (0.9 lb) 32% protein supplement

Ration No. 4
10 kg (22 lb) cereal silage (65% moisture)
3.2 kg (7 lb) barley grain
0.25 kg (0.55 lb) 32% protein supplement

These rations have been formulated to supply the calves with the quantity of feed they should receive at the midpoint of the feeding period. At the start of the feeding period, calves should be fed about 10 to 15 per cent less, whereas at the end of the feeding period they should be consuming 10 to 15 per cent more. In very cold weather the average daily gain of the calves will probably be less than the target gain. To maintain the targeted rate of gain through very cold weather increase the grain portion of the ration by 20 per cent.

If the calves are implanted, average daily gains could be about 10 per cent higher than the target gains. The protein and mineral requirements of these calves should be increased by about 10 per cent relative to the energy content of the ration. As a result, calves fed ration No. 3 or No. 4 for either of the target gains should receive an additional 0.2 kg (0.44 lb) of 32 per cent protein supplement.

Remember that "average" ration using "average" feeds may not be optimal for your situation. Ideally, rations should be designed for the actual feeds and management system involved.

These sample rations for growing calves illustrate the following points:

- The quality of roughage affects the requirement for supplemental energy and protein.
- Greenfeed and cereal silage are normally relatively low in protein. Most growing rations based on greenfeed or cereal silage require supplemental protein.

Some other points to remember are:

- High quality legume forages, if consumed at adequate levels, can supply adequate energy and protein in the growing ration to achieve gains of about 0.5 kg (1.1 lb) per day without supplemental grain.
- Grass hay is relatively low in energy and protein. As a result it is usually necessary to feed grain and a protein supplement with grass hay.
- Grains that are high in protein will decrease the need for a protein supplement.
- When protein is the most limiting nutrient, a protein supplement is usually a more economical source of protein than is grain.

Winter feeding of bulls

The herd bulls are often the most mismanaged animals in the herd. In the winter they are often forgotten and left to fend for themselves. On the other hand, they are sometimes pampered to the stage of becoming overly fat. Overfeeding of bulls can cause more harm than underfeeding, but neither situation is good. Overfeeding results in reduced libido (sexual drive) and mating ability. This can have disastrous effects on the calf crop. A good rule of thumb is that a mature bull needs about 50 per cent more feed than a mature cow. The requirements of growing bulls are slightly higher than those of mature bulls.

The following rations will meet the energy and protein needs of a 500 kg (1100 lb) bull growing at the rate of 0.7 kg (1.5 lb) per day. No allowance has been made for wastage in these rations.

Ration No. 1
9 kg (19.8 lb) grass hay
4.8 kg (10.6 lb) oats or barley grain

Ration No. 2
10 kg (22 lb) alfalfa-brome hay (50:50)
3.7 kg (8.1 lb) oats or barley grain

Ration No. 3
9 kg (19.8 lb) good quality greenfeed
4 kg (8.8 lb) oats or barley grain

Ration No. 4
22 kg (48.4 lb) cereal silage (65 per cent moisture)
4 kg (8.8 lb) oats or barley grain

Rations number 1 and 2 do not require supplemental calcium or phosphorus. However, the grain fed in ration 3 or 4 should have 1 per cent ground limestone added to ensure that the ration provides more calcium than phosphorus.

The following rations will meet, without allowance for wastage, the energy and protein needs of an 800 kg (1760 lb) mature bull.

Ration No. 1
14 kg (30.8 lb) grass hay

Ration No. 2
13 kg (28.6 lb) alfalfa-brome hay (50:50)

Ration No. 3
9 kg (19.8 lb) good quality oats or barley straw
5 kg (11 lb) good quality alfalfa

Ration No. 4
10 kg (22 lb) good quality oats or barley straw
2 kg (4.4 lb) oats or barley grain
1 kg (2.2 lb) 32% protein supplement

Ration No. 5
12.5 kg (27.5 lb) good quality greenfeed

Ration No. 6

30 kg (66 lb) cereal silage (65% moisture)

In addition, mature bulls should have access to a 1:1 mineral on a free-choice basis.

Both growing and mature bulls should receive either a trace mineralized or cobalt-iodized (blue) salt on a free-choice basis. They also require at least 50,000 IU of vitamin A per head per day.

Managing the feeding program

Feed analysis and ration formulation do not replace the need to actively manage the feeding program. Many factors can substantially affect the performance of cattle, especially during the winter feeding period. The manager must constantly be aware of changes in weather, feed quality, waste and feed intake. Performance in terms of body condition and weight change must be monitored to insure that the feeding program is achieving the desired results. The use of a condition scoring system and a livestock scale to measure these factors is recommended.

Range and pasture nutrition

During the winter considerable emphasis is placed on meeting the nutrient needs of cattle. However, in the summer, range or pasture forage make up essentially the entire diet of cattle. The quality of range and forage for beef cattle is highly variable. Consequently, the performance of cattle on pasture is highly variable as well. Green, lush, immature forage is an excellent source of most nutrients while ripe, dry, mature forage is a poor feed. Research into cattle weight gains compared to forage quality has been useful for identifying the times during the pasture season when forage will not meet the animal's nutritional requirments.

In east-central Alberta, staff of Alberta Agriculture evaluated the carrying capacity of rangeland reseeded to Russian wildrye as compared with native range. This study was conducted on the Sounding Creek Community Pasture near Oyen between 1977 and 1980 (table 36).

The nutrient value of the forages deteriorated as the summer progressed. With Russian wildrye, however, the nutrient content actually improved between mid-September and mid-October. This is an indication of the value of grasses such as Russian wildrye for fall pasture.

The same study also compared the average daily gain of the cows and calves on each of the pastures (table 37).

Table 36
Average nutrient content of pasture forage samples (east-central Alberta)

	Native Range			Russian Wild-Rye		
	Protein (%)	ADF (%) *	Phosphorus (%)	Protein(%)	ADF (%) *	Phosphorus (%)
June 15	10.7	34.8	0.16	10.9	35.0	0.25
July 15	8.0	38.4	0.14	9.1	37.3	0.20
Aug. 15	6.9	38.3	0.11	6.7	40.0	0.14
Sept. 15	5.9	40.5	0.08	5.6	44.6	0.11
Oct. 15	4.6	42.0	0.07	7.1	38.3	0.12

*ADF = Acid Detergent Fibre (higher ADF values indicates lower digestible energy content)

Table 37
Mean average daily gains of cows and calves on Russian Wildrye and native pastures

	Native Range		Russian Wild-Rye	
	Cows kg lb	Calves kg lb	Cows kg lb	Calves kg lb
June 15 to July 15	1.12 (2.47)	0.91 (2.00)	0.18 (0.40)	0.67 (1.47)
July 15 to Aug. 15	0.36 (0.80)	1.15 (2.53)	0.40 (0.87)	1.14 (2.50)
Aug. 15 to Sept. 15	−0.55 (−1.20)	0.88 (1.93)	0.20 (0.43)	0.92 (2.03)
Sept. 15 to Oct. 15	−0.49 (−1.07)	0.35 (0.77)	0.06 (0.13)	0.64 (1.40)
Overall Average	0.11 (0.25)	0.82 (1.81)	0.35 (0.78)	0.84 (1.85)

Cows on the native pasture gained considerable weight in the first month on pasture, but they lost an average of 62.4 kg (137 lb) per head during the last two months on pasture. Calf performance in the last month on pasture was markedly below the first three months.

The cows and calves on the Russian wildrye pasture consistently had poorer first-month performance than those on native range. However, in the last two months on pasture they consistently outperformed the cows on native range. Even with the Russian wildrye, calf performance was reduced in the last month on pasture (table 37).

Although rainfall is generally more plentiful in the northern and western regions of the province, calf gains in September were often lower than earlier in the summer. Late summer and fall frosts reduce the nutritional value of native plants more severely than the value of many domestic species. Domestic species, if managed properly during the growing season, provide superior quality pasture for late summer and fall grazing. In a 5 year study conducted on a Grey Wooded soil near Dawson Creek, British Columbia, it was cow performance rather than calf performance that reflected the difference in nutritional quality of the pasture (table 38). The Dawson Creek study shows gains of cows were increased by a factor of 13.6 on tame pastures compared with native pastures. Gains of calves were 5.2 times greater on the tame pastures.

The Dawson Creek data also shows that tame pastures may be used to extend the grazing season in northern grey wooded areas without losing any gains on calves (table 39). The combination of native and tame pasture gave a few more days of grazing with no significant loss of gains in either cows or calves.

Tame or developed pastures are naturally more productive than brush or native pastures in the grey wooded soil zone. The Dawson Creek study indicates that tame pastures can produce from 5 to 10 times as much beef per acre as native pasture. The native pasture at this location was considered good to excellent and probably represents maximum productivity for native range in this zone.

Brush pastures represent an inexpensive source of forage if managed properly. The effective grazing season is usually less than 100 days if cattle performance is used as the measure of nutritional value. Range improvement measures are important for extending the grazing season. Low cost methods such as chemical brush control, burning, water and trail development, and fencing may be preferred over the high costs of complete clearing, breaking and seeding. Woody regrowth on cleared sites is often a problem, especially where removal of roots is incomplete. Intensive grazing at strategic times helps to control woody regrowth, but fences must be constructed to permit this practice.

Table 38
Beef production per acre from native vs. tame pasture[a]

	Tame	Native
Calves	186.6 lb	35.6 lb
Cows	87.0 lb	6.4 lb
TOTAL	273.6 lb	42.0 lb

[a] Based on a two-year study at Dawson Creek, B.C.

Table 39
Mean average daily gains of cows and calves on native and tame pasture[a]

	Tame[b]	Native[bc]	Native & Tame[d]
Calves	1.00 kg	0.98 kg	0.97 kg
Cows	0.57 kg	0.25 kg	0.26 kg
Average # of days grazing	137	122	125

[a] Based on a one-year study at Dawson Creek, B.C.
[b] Alsike clover, creeping red fescue and timothy pasture grazing in a 3 pasture rotation.
[c] Calmagrostis canadensis major species but many forbs available.
[d] Native 90-100 days followed by tame for 30-40 days.

Genetic Principles, Breeding Systems and Breed Evaluations

Genetic Principles

Introduction

The physical appearance and characteristics of an animal are influenced by its genetic make-up and by the environment in which it has been raised. Since both factors can influence the results, it is important to know which has the greatest influence on the trait in question. Geneticists refer to the degree to which the genetic make-up is expressed (separated from the effect of environment) as heritability. The higher the heritability the greater the effect of selection. The lower the heritability the greater the effect of environment (management). When planning a breeding program, traits of high (greater than 50%) or moderate (30-50%) heritability should be improved by selection. Traits of low (less than 30%) heritability should be improved by management changes or crossbreeding. The following table lists the heritability of a few of the more common traits.

Table 40
Heritability of some traits

Trait	Heritability %
Calving interval (Fertility)	10
Birth weight	40
Weaning weight	30
Cow maternal ability	40
Cow milking ability	30
Feedlot gain	45
Pasture gain	30
Efficiency of gain	40
Final feedlot weight	60
Muscling	50

No two animals are exactly alike. Therefore, when measuring any trait, you will find a range of values. In a large population this range expresses itself as a bell curve (figure 22).

Two-thirds of the population will fall between the dotted lines and not be too far from average. One-sixth will be much worse than average and one-sixth will be much better than average. There is no guarantee that those animals in the extreme one-sixth area are genetically different, but the chances are very good that they are. Environment can explain some differences but the further from the mean you go, the greater the probability that the variation is genetically caused. If the breeding objective is to make progress by selection, the quickest results will be obtained by selecting for a trait from amongst the extremes of the population.

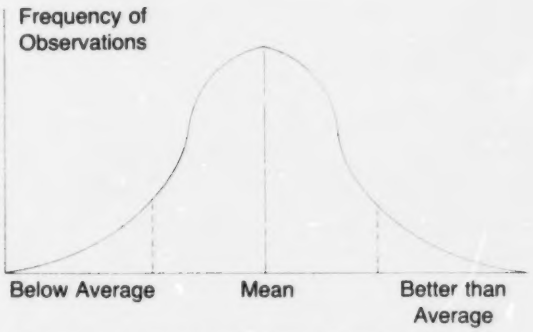


Figure 22 - Curve showing distribution of heritable characters.

Breeding principles

A sound breeding program, based on a selection program, will depend on the following factors:

Number of traits selected - The more traits selected, the slower the progress made for any one of them. However, the cumulative advantage of selecting for several traits at once may be greater than the single advantage of selecting for only one. Individual experience will dictate which is best.

Selection pressure - This makes reference to the distribution curve. The greater the difference between the selected animals and the herd average, the faster will be the movement toward the selection objective. Also, if most of the poor producing animals are replaced by good producing animals each year, progress will be faster than if only a few of the poor producing animals are replaced each year.

Generation interval - This interval is the length of time it takes to turn over the breeding herd of both bulls and cows. The faster both cows and bulls are replaced by superior animals, the more rapid the genetic improvement will be. This means culling a high percentage of poor producing cows each year and using an individual bull for only one or two years. Both bulls and cows must be replaced by animals superior in the traits selected if progress is to be made. If one selects for weaning weight in the cow herd, then buys unknown or untested bulls, little progress in weaning weight will result.

Heritability - Heritability is the proportion of the physical variation for any trait which is attributable to the genetic make-up of the animal. The heritability estimate must be determined by

research. The more heritable the trait, the more rapid change through selection can be.

Compatability of traits selected - Some traits tag along with each other and may be beneficial or detrimental to the overall goal. Feed efficiency improves as daily gain improves. Dam milk production and calf weaning weight move together. Mature size and yearling weight increase together. Unfortunately calf birth weight tags along with mature size, yearling weight and average daily gain on feed. Birth weight increases do not pose a problem unless they adversely affect ease of birth. Some research has shown that birth weight can be held down while increasing weight gain, but progress is slow.

Another way to overcome undesirable tag-along traits is to address the problem directly. Because heifers have the greatest incidence of calving difficulty, breed them to a bull known to have easy-to-calf progeny. If mature size is a concern, try to breed cows of satisfactory size to large high-gaining bulls. This way the original selection objective can be met through a breeding system. Selection objectives can then be changed to fit the new program.

The main point to be made about trait compatability is that once the tag-along traits start to cause problems, progress in the major trait becomes more difficult because selection against the tag-along trait slows down improvement in the major trait.

Breeding systems

There are many types of breeding systems and variations within each type. We will deal with straight breeding, cross breeding and composite systems. All of these systems can achieve some measure of improvement over no systems at all. No one system works best for all people. The advantages and disadvantages of each are noted in the following discussion.

Straight breeding

Straight breeding involves breeding cattle of only one breed. The purebred industry uses this system to maintain breed purity. It involves breeding cows to bulls of the same breed and selecting for performance, type, pedigree or combinations of all three. Three main variations of straight breeding are used.

Inbreeding

Once popular, inbreeding is used less today. Related animals are mated in an attempt to combine favorable genes in the offspring. All genes come in pairs. If each gene pair can be made identical (i.e., homozygous) and favorable, it should be possible to produce better offspring. Unfortunately, undesirable genes are also "fixed" in the homozygous state by inbreeding and cause a decline in the vigor of the offspring. Culling of poor animals must be severe if real gain is to be achieved. Most producers find the culling rate too expensive. As inbreeding increases, the health and vigor of the herd decline and productivity of the remaining cattle is lower. Be certain that the increased purity of the breeding herd is worth the cost.

Linebreeding

This is a mild form of inbreeding. Instead of mating close relatives, progeny of a special parent are selected for use in the breeding herd. Linebreeding can be easily carried out using semen from a particular bull for a long time to increase the number of his progeny in the herd. After this bull is no longer used, he is usually followed by one or more of his own male progeny. It is obvious that the longer a sire is used the higher the level of inbreeding. Most practitioners of line breeding remove a sire when sire-daughter matings cannot be avoided. He will then be replaced by a son. It is important to select replacements carefully in this program because inbreeding will turn up duds as well as superior offspring. Linebreeding will eventually stop producing superior offspring and then new genetic material should be introduced.

Outbreeding

This involves mating animals that are largely unrelated. The main principle is to breed the best stock available. The progeny will show a certain amount of heterosis. The objective is to select a sire that is strong in a trait in which the cow herd is weak. This form of corrective breeding will not develop new genetic material for seed stock herds, but the level of herd production will be better than with either inbreeding or line breeding. It is suitable for commercial herds that wish to maintain a one-bred identity. It is also ideal for seed stock herd owners who wish to produce for "middle of the road" producers. The sires selected for breeding from herds like these may not breed as true as inbred cattle, but the increased vigor and expanded gene pool make up for the increase in variability. A program that uses ROP selection will find progress easier with this system because of the expanded gene pool.

The discussion of these breeding systems has been general. A breeding herd may use variations of all three systems at one time. The most consistent progress will be made if the breeding results

Examples of Inbreeding:

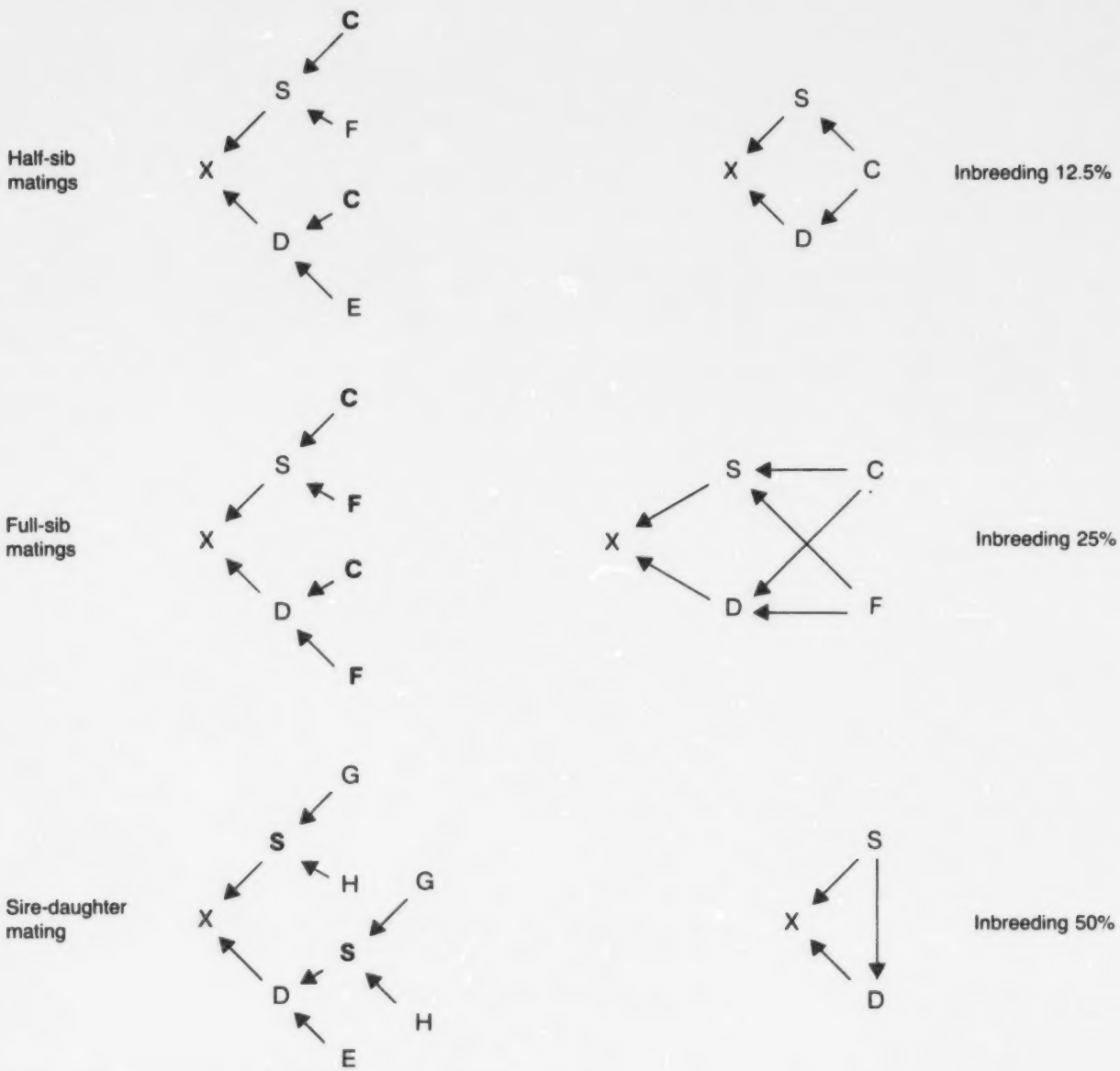


Figure 23 - Examples of inbreeding

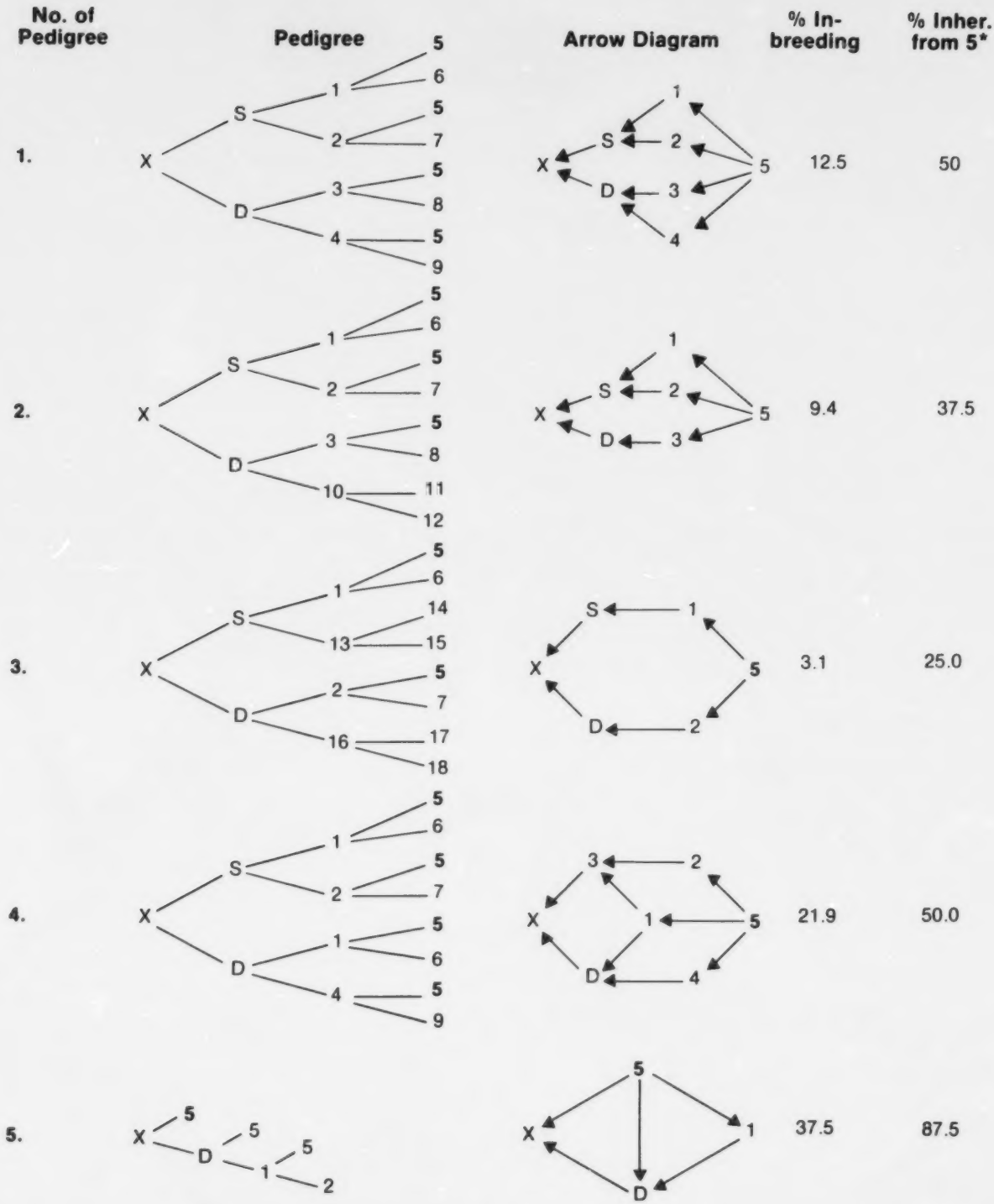
Note: Before starting an inbreeding program be certain to start with superior breeding stock and maintain a rigorous ROP program for selection and culling.

are monitored. The best monitoring system is a performance test program. It should be used both to cull poor cattle and to select replacements. It should also be used when buying replacement sires.

Crossbreeding

Research studies have shown the advantages of crossbreeding. Many crossbreeding systems have been devised to try to take full advantage of heterosis (hybrid vigor). The three main types of crossbreeding are specific breed crosses, rotational crosses and composite or synthetic breed development. The maximum potential hybrid vigor is obtained when a hybrid female is mated to an unrelated sire. The more unrelated the parents the greater the heterosis.

Heterosis is the phenomenon of a superior level of performance for certain traits attained by crossbred individuals over and above the average



*Probable percent of inheritance received from ancestor 5.

Figure 24 - Examples of linebreeding: Pedigrees and arrow diagrams of the pedigrees which illustrate some different systems of linebreeding.

performance of their straightbred parents. Heterosis is measured experimentally as the difference in performance of crossbred animals from the average contemporary performance of straightbred animals of the breeds involved in the cross. This difference is usually expressed as a percentage of the average performance of the straightbreds. It is calculated by the following formula:

$$\% \text{ Heterosis} = \frac{\text{Crossbred avg. - Straightbred avg. x 100}}{\text{Straightbred average}}$$

This is the percent improvement in a trait relative to the average of the parents.

For example, if average weaning weight of the straightbred calves of breed A was 206 kg (455 lb) and for breed B calves was 202 kg (445 lb), the average of the straightbreds would be 204 kg (450 lb). If average weaning weight of the crossbred calves was 213 kg (470 lb), the percent heterosis would be estimated as:

$$\% \text{ Heterosis} = \frac{(213\text{-}204) \text{ x } 100}{204} = 4.5\%$$

Striving for heterosis is not always be beneficial. Some breeds are so much better in a particular trait (e.g., Holsteins and fluid milk production) than other breeds that the resulting crosses are actually lower in production than the best producing parent line. Heterosis is still there because the hybrid cows are better than the average of the two parents though not better than the best parent. When viewed for all traits (eg., cream, milk solids, reproduction, useful age) the hybrid may be better, but if all the income is generated by one trait, it becomes uneconomical to improve the others at the expense of milk production.

The improvement that one can expect in beef cattle from crossbreeding has been examined. In studies done at Lethbridge by Dr. L.J. Sumption, the following effects of crossbreeding on performance within the British breeds were noted:

The comparison of performance of crossbred and straightline bred calves produced by straightbred cows showed:

- *3% more crossbred calves survived to weaning
- *5% greater weaning weight in the crossbred calves
- *6% greater yearling weight in crossbred steers
- *8% greater yearling weight in crossbred heifers
- *crossbred heifers were 10% younger than straightbreds when they showed their first heat cycle.

The comparison of performance of crossbred and straightbred cows producing crossbred calves showed:

- *Crossbred cows had a 10% higher conception to first service.
- *Crossbred cows had a 6% higher pregnancy rate at the end of the breeding season.
- *Crossbred cows had 7% more calves at weaning.
- *Crossbred cows produced 6% more weaned weight per calf.
- *Crossbred cows produced 15% more pounds of calf weaned per cow bred.

The effects of crossbreeding are increased calf survival, higher fertility, earlier maturity and faster growth rates. The three-way cross had a better level of performance than the two-way cross.

Crossbreeding will require changes in management, some of which may be regarded as disadvantageous. Some of these are:

- Most systems require the use of two or three breeding pastures or the use of an artificial insemination program. Multiple breeding pastures should be considered when the herd is large enough to use a number of bulls. Crossbreeding can be adopted in small herds by the use of AI and a clean-up bull of a different breed.
- Heavier-milking crossbred cows, particularly first calf heifers, require a higher level of management than low-milking cows.
- Some crosses require different postweaning management. The crossbred steers of some of the larger breeds should go straight to the feedlot and be moved to a high energy ration without a "growing out" period. Crossbred heifers of the larger breeds should be fed to be 34 kg (75 lb) heavier than the British breed heifers at first breeding.
- More effective marketing may be required, particularly when selling feeder cattle.

Specific systems

Specific breed systems use a single cross of specific breeds with maternal traits (milking) to produce hybrid females as brood cows for the herd. These females are bred to terminal meat trait sires. Heifers from the terminal cross sires are not suitable as mother cows, so they are all sold to slaughter. The major problem with the specific terminal cross system is maintaining a female breeding herd. The maternal trait hybrid females must either be raised in a separate or herd be purchased as replacements.

Table 41
Typical 3-way crosses

Line A	x Line B = Hybrid female	x Line C
Hereford	Salers	Charolais
Angus	Tarantaise	Maine-Anjou
Shorthorn	Simmental	Gelbvieh

Operators have the option of buying all their breeding stock or raising their own in separate

herds. If they raise their own female replacements, they will need to devote about a half of the total herd to this aspect of the enterprise. If they wish to raise the meat sires also, a further 10 per cent of the cow herd will have to be devoted to this cause. Just 40 per cent of the herd will be left for the terminal cross. Only large herds can try such a system because so many breeding pastures are needed unless a full AI program is used. This system makes the most of heterosis, approaching 100 per cent on the terminal cross, if all replacement females are purchased. Its total effect is reduced, however, because of the large number of straightbred females required to produce the hybrids.

Rotational crossing

2-way rotation - The simplest system involves two sire breeds (e.g., Hereford and Angus). The crossbred heifers are kept and bred to the other sire breed, i.e., the breed other than the one to which their own sire belongs.

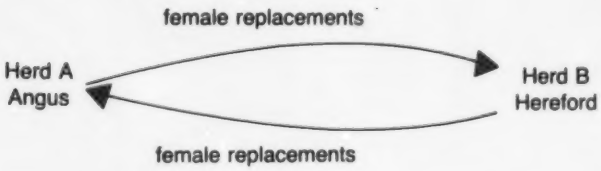


Figure 25. A 2-way rotation

This system requires only two breeding pastures and uses hybrid females in all cases. It is capable of utilizing only about 66 per cent of the total possible heterosis.

Selection of breeds is a little more complex than in the specific breed systems because each breed will be both maternal and terminal. The best choice will be breeds that have superior milking ability. This system works best in herds using two or four bulls. Small herds (one bull herds) may also use a variation of this system by using a bull of one breed for three years and then a bull of the other breed for three years. Heterosis is not high but it is present.

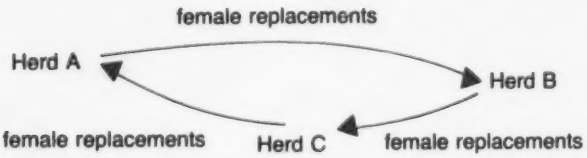


Figure 26. 3-way rotation

3-way rotation - Three breeding groups are required and up to 87 per cent of total heterosis can be obtained. This system takes the greatest advantage of heterosis. Its main disadvantage is breed selection. Highly specific breed types are not likely the best choice because all breeds will be used as a source of both maternal and terminal traits. The three-way crossing system can be recommended for use in herds requiring three to six bulls.

Over-3-breed rotation - Rotation systems using more than three breeds do not gain much in heterosis and only increase the complexity of the breeding system. If you wish to use several breeds try a composite or a rotational composite.

Rotation-terminal - The major disadvantage of the three-way specific crossing system of having about 50 per cent of the females as straightbred can be removed using this system.

Allocate about 40 - 50 per cent of the breeding females to a two-way rotation system. Select the best maternal type cows for this group. The purpose of this subherd is to get productive female replacements. Bulls of breeds noted for maternal characteristics, while being compatible with the overall objective of meat production, should be selected for this herd.

The balance of the breeding herd is used with terminal sires. Replacements for the terminal herd will come from the older or less productive but still useful cows in the rotation group. The bulls can be selected from a meat type breed. Use a breed that will blend with the cow herd and produce beef that meat markets demand while maximizing production.

Other systems - There are many other systems of crossbreeding for large breeding herds. They will not be discussed here. See the bibliography for fact sheets available from Alberta Agriculture that explain in greater detail how to set up such complex systems. In most cases these programs usually need to be tailored for the specific herd and management conditions.

Composites

Research at Clay Center Nebraska has shown that a mix of breeds in one breeding herd can maintain approximately 85 per cent heterosis while the herd remains closed, i.e., sires and replacement heifers are selected from within the herd. New blood should be introduced every few years to offset inbreeding, but in larger herds heterosis remains relatively high.

One of the breeding herds at the University of Alberta ranch at Kinsella is a composite of Charolais, Angus and Galloway with some Brown Swiss and Simmental added several years after the initial cross. The main herd has shown a consistent superiority to the purebred herd maintained on the same premises after 20 years of breeding and selecting.

The most difficult job with a composite herd is marketing. The color patterns can be extremely varied. If the selection program is good, all the cattle will have a good growth rate regardless of what

color they are, but it can be difficult to persuade buyers of this unless they are crossbred enthusiasts.

Starting a composite is a bit difficult. If the herd is large, select several sires from the breeds you wish to include and breed a number of females to each sire. As heifers are selected from these matings, replace the original females. After a few years of preparatory breeding with outside sires, the herd is closed and both sires and dams are selected from within the herd. Performance criteria should be the main focus for selection. Some people have tried to stabilize color patterns a bit, but this only holds down performance progress.

Deciding which breeds to select in a composite program is tough. Since the herd is closed it must be a dual purpose herd, that is, it must be both maternal and terminal, unless it is to be a part of a larger program. In this case it might, for example, serve the purpose of a maternal composite herd of females to breed to terminal sires. In a maternal composite herd a combination using the British breeds (Hereford, Shorthorn Angus) and some of the dual purpose European breeds (Simmental, Limousin, Salers, Gelbvieh) would be good choices. There are many other breeds that are also suitable. First choices will depend on available breeding stock and personal preferences.

Summary

- Any system of breeding must be flexible. Over the course of time a producer may decide to change the selection of breeds in the crossbreeding program. Whatever breeds are used, it is important to select only superior females for herd replacements.
- The future genetic improvement of a herd will depend on how intensively a breeder selects to improve the genetic merit of the herd and on the level of genetic merit within the herds of seed stock suppliers.
- Select the best bulls possible from the breed of your choice. A poor bull will produce poor calves regardless of whether the calves are crossbred or straightbred.
- Never base the evaluation of a breed on the basis of the progeny of one bull, as there are wide variations within all breeds.
- Never evaluate a breed on the basis of a few individuals or progeny of the breed.
- Management may have to be altered to get the best results from crossbreeding. One kind of crossbred may respond differently to a certain environment than another kind of crossbred or a straightbred animal.

Breed evaluations

There are over 30 breeds of cattle in Canada from which breeders can choose breeding stock. This is both an advantage and a problem. The advantage is the ability to tailor-make a breeding program. The disadvantage is the difficulty in picking the best breeds for the job. Table 42 lists some of the physical characteristics of the various breeds. The table is only a rough guideline. Breeders have made major improvements to all breeds, but fairly substantial differences still exist within the various breeds. Therefore, there may be strains within breeds that are suitable for different tasks.

Evaluations of breeds for birth weight, mature weight, and milk production (such as the one done at the U.S. Meat Animal Research Centre) provide needed information on some of the new breeds. One study was designed to examine a full range of economic traits relating to growth, feed efficiency, reproduction, maternal ability and carcass and meat traits.

The study used straightbred Hereford and Angus foundation cows. About 10 bulls from each breed in the study were used each year. An average of 200 calves from each sire breed were produced in the first year of the study, with comparable numbers in subsequent years.

Cycle I of the study included Hereford, Angus, Jersey, South Devon, Limousin, Simmental and Charolais sires. Starting with the 1973 calf crop a similar evaluation of the Red Poll, Brown Swiss, Gelbvieh, Maine-Anjou and Chianina breeds was begun at Clay Centre. The study of these breeds was designated as Cycle II.

Cycle III included the study of Brahman, Sahiwal, Pinzgauer and Tarantaise. All breeds was compared with the Hereford and Angus as standard.

The data obtained for each breed are primarily from crossbreds. The sires from the breeds tested were bred to Hereford and Angus cows (phase 1) and to crossbred cows (phase 2). At this stage no attempt is being made to evaluate the breeds as purebreds.

The data collected for breed of sire included: calving ease, birth weight, average daily gain to weaning, 200-day adjusted weight, gain on feed, carcass traits, age at puberty for female progeny, weight at puberty and percent pregnant.

The test was divided into two phases. The first phase evaluated the breed as a sire crossed on Angus and Hereford females. The results were compared to Hereford x Angus crosses.

The second phase tested the breed as a crossbred

Table 42
Physical Characteristics of Breeds[a]

Breed	Birth weight		Mature weight				Milk production		
			Cows		Bulls		% Fat	Milk	
	kg	lb	kg	lb	kg	lb		kg	lb
Aberdeen Angus	32	70	522	1150	794	1750	(4.4)	1800	4000
Ayrshire	34	75	522	1150	794	1750	3.9	3900	8600
Blonde d'Aquitaine	43	95	703	1550	1134	2500	3.8	907	2000
Brown Swiss	36	80	590	1300	930	2050	3.9	3629	8000
Charolais	43	95	794	1750	1089	2400	(4.0)	(1814)	(4000)
Chianina	45	100	907	2000	1270	2800	(4.5)	(1134)	(2500)
Galloway	27	60	454	1000	680	1500	(4.0)	(1588)	(3500)
Gelbvieh	43	95	635	1400	1043	2300	4.1	3175	7000
Guernsey	32	70	499	1100	728	1600	4.5	3402	7500
Hereford	34	75	544	1200	839	1850	4.4	(1588)	(3500)
Highland	30	65	408	900	680	1500	---	---	---
Holstein	41	90	635	1400	1089	2400	3.8	4309	9500
Jersey	27	60	385	850	635	1400	5.0	3175	7000
Limousin	36	80	590	1300	953	2100	4.5	(2268)	(5000)
Lincoln Red	34	75	590	1300	907	2000	3.7	3629	8000
Luing	(34)	(75)	544	1200	953	2100	---	---	---
Maine-Anjou	45	100	907	2000	1247	2750	3.7	2722	6000
Marchigiana	43	95	658	1450	1179	2600	---	---	---
Meuse-Rhine-Ijssel	41	90	635	1400	1089	2400	3.6	4309	9500
Murray Grey	30	65	522	1150	826	1800	(4.4)	(1814)	(4000)
Normandy	(39)	(85)	635	1400	998	2200	4.0	3311	7300
Pinzgauer	43	95	590	1300	907	2000	4.0	3175	7000
Red Angus	32	70	522	1150	794	1750	(4.4)	(1814)	(4000)
Red Poll	34	75	522	1150	726	1600	3.7	3538	7800
Romagnola	45	100	635	1400	1089	2400	---	---	---
Saler	(36)	(80)	590	1300	907	2000	3.7	2585	5700
Shorthorn	34	75	522	1150	794	1750	4.2	(1814)	(4000)
Simmental	43	95	748	1650	1089	2400	4.0	3629	8000
South Devon	36	80	635	1400	953	2100	4.2	2948	6500
Tarentaise	36	80	590	1300	816	1800	3.7	2631	5800
Welsh Black	34	75	522	1150	839	1850	4.0	3175	7000

[a] Numbers in brackets are best estimates.

female mated with a third sire breed. The traits measured were all those mentioned earlier plus average calving interval, percentage pregnant as three-year olds and weight at 3.5 years.

The research centre issues periodic reports that summarize all the findings to date. Provincial livestock specialists have access to these publications, or you may obtain your copy by writing to:

U.S. Meat Animal Research Center
Agricultural Research Service
Clay Center, Nebraska, U.S.A.
68933

Ask for the Germ Plasm Evaluation Program reports.

Various research trials have been carried out by Agriculture Canada Research Stations. See the bibliography for a list of their publications.

Breed associations also collect research reports in which their breed has been tested. They can point out the features in which their breed has excelled.

The federal ROP program summarizes progeny results for bulls on ROP and issues an annual report. This is called the sire monitoring program. Provincial livestock specialists, artificial inseminators and district agriculturists usually have copies of these reports, or you can obtain copies directly from Agriculture Canada on request. The report details progeny results for each sire used in over five herds with about 50 calves. Calving ease, weaning weight, and gain on feed are the traits reported. This report will not evaluate breeds conclusively, but it does indicate how some bulls of the various breeds are doing.

A breeding program will be successful if economic traits are selected for improvement. If heritability is high, use ROP selection. If heritability is low, a crossbreeding program should be used. Quicker improvement will be made with good quality breeding stock from a tested herd than with poor quality or untested stock. Finally, keep at it. Progress may be slow at first but will accelerate once good females begin to replace poor ones.

Animal Health

Introduction

The subject of animal health is wide ranging. Major areas with which veterinarians are concerned include diseases of animals, nutritional deficiencies, genetics, the influence of housing systems, and plant and other poisons. This section is included to make producers more aware of the various conditions that will affect their cattle and consequently limit production. The causes, symptoms, prevention and treatment of the diseases of most economic importance to cow/calf production are included. No specific doses of drugs for treatment are given because the doses vary from area to area, with the size and type of animal and the product used. This information can be obtained from the local veterinarian.

Disease prevention and proper management are the keys to a successful animal health program. Producers should involve their veterinarian to a greater degree at the preventive level. In the long run this practice is far more profitable than waiting until the disease has become advanced before consulting a veterinarian. Too often, the veterinarian is only called after all else has failed. The chance of saving an animal under these conditions is usually minimal and if the veterinarian is not successful, the visit is frustrating for both the producer and the veterinarian.

In recent years, the fixed and variable costs of a beef cow/calf enterprise have increased much more than have the returns on investment. This cost-price squeeze is forcing beef producers to seek methods of increasing production and lowering production costs. One of the best methods available is a preventive herd health program that focuses on the disease and management problems that cause economic loss. Economic losses in a cow-calf enterprises result from three major causes: clinical disease, subclinical disease and variations in management that result in failure to achieve optimum production. The overall incidence of clinical disease in beef cattle is low compared with other species of livestock. In the area of disease control, the most beneficial role of the veterinarian in programmed animal health is to ensure that preventive and control measures are followed to prevent potentially large losses from disease outbreaks. The greatest economic gain in most herds is made by increasing the efficiency of production. A veterinarian through a herd health program can make a significant contribution here.

Herd health and management calendar

Precalving and calving season (early spring).

* Identify cows with vaginal prolapses for culling.
* Watch for abortions and submit aborted fetuses for diagnosis.
* Check for lice and treat if infested.
* Discuss vaccinating the cow herd for calf scours with a veterinarian.
* Prepare for calving, especially for calving problems.
* Obtain a supply of electrolyte solution and antibiotic preparations for treating scours.
* Inject calves with vitamin E and selenium, and vitamins A, D and E if necessary.
* Watch for calf scours and pneumonia.
* Keep calving areas clean, dry and well bedded.
* Record birth dates and calf birth weights and identify calves.
* Re-assess nutrient requirements and performance of heifers and cows and make the necessary changes.

Breeding season (early spring and early summer)

* Check daily for scours and pneumonia in calves
* Evaluate the fertility of all breeding bulls:
  - semen quality
  - physical examination
  - libido
* Have all breeding females that suffered reproductive problems during or following calving examined by your veterinarian before they are turned out for breeding.
* Assess the bull to female breeding ratios required.
* Prepare teaser animals if AI is to be used.
* Vaccinate all replacement heifers for IBR, BVD, and vibriosis, if necessary, 30 days before breeding.
* Vaccinate cows for vibriosis, if necessary, about two weeks before breeding.
* Vaccinate all calves over two months of age for blackleg.
* Castrate, dehorn and implant calves.

Preweaning and weaning (fall)

* Prepare calves for weaning. Preconditioning should include vaccination for blackleg and related diseases and IBR/PI_3. If ITEME is a problem, include a hemophilus vaccination.
* Pregnancy test and cull nonpregnant and poor health risk cows.
* Treat for warbles and external parasites.
* Wean calves with a minimum of stress. Watch calves for pneumonia and treat promptly.
* Weigh calves and record weaning weights.
* Make initial selection of heifer and bull replacements.
* Evaluate performance of the breeding herd by calculating:

- percent calf crop
- weaning weights
- death loss percentage
- cost per pound of calf marketed.

* Vaccinate replacement heifers for BVD about three weeks after weaning.

Wintering period

* Take inventory of feeds available and submit it for feed analysis.
* Work out rations for the different classes: pregnant heifers, pregnant cows, heifer replacements, bull replacements, breeding bulls, feeder calves.
* Initial vaccinations for calf scours vaccines may be given in the fall instead of midwinter.
* Check cows each day for signs of heat and rubbing or scratching due to external parasites.
* Watch for abortions and submit fetuses with part of the *placenta* to a veterinary diagnostic lab for analysis.
* Increase your knowledge about the beef business through:
  - research and extension publications
  - extension meetings
  - farm press
  - commercial firms and consultants
  - nutrition and management programs.

Table 43
Summary of vaccination procedures for the control of some infectious diseases in western canadian beef herds

Disease	Time to Vaccinate	Remarks
•Infectious bovine rhinotracheitis (IBR) •Para-influenza (PI^3)	At least 3 weeks before weaning, before breeding or at entry into a feedlot. In feedlots, the vaccine should be given within 24 hours after arrival.	Intranasal vaccine is safe in pregnant cows. Intramuscular vaccination may cause abortion. If calves are vaccinated at 2 to 4 months of age, they should receive a booster shot when they are 6 to 7 months old.
Clostridial Disease •Blackleg (chauvoei) •Malignant edema (septicum) Blackney and Malignant Edema	Calves after 2 months of age. Bacteria-vaccines and and toxin-vaccines include:	All beef cattle should be vaccinated for blackleg and malignant edema. The necessity for vaccination for the other clostridial diseases depends on the prevalence of each disease in the particular geographical area. A few cases of infectious hepatitis, bacillary hemoglobinuria and tetanus have occurred sporadically in Western Canada.
•Infectious hepatitis (novyi type B)	2-way bacteria vaccine, for blackleg and malignant edema	
•Bacillary hemoglobinuria (novi type D)	3-way bacteria-vaccine for blackleg, malignant edema and tetanus.	
•Enterotoxemia types B,C, & D	8-way (contains both bacteria-vaccine and toxin-vaccine) for all those to the left.	
•Bovine virus diarrhea (BVD)	Heifer calves 3 to 4 weeks after weaning. Breeding females at 1 month before breeding.	A killed vaccine is available for pregnant animals whereas a modified-live intramuscular vaccine is available for use in open animals that are not in contact with pregnant animals.
•Vibriosis	Vaccinate cows 10 days before breeding season. Vaccinate heifers 50 days and again 10 days before breeding season.	Booster vaccination must be given close to time of breeding to ensure a high degree of immunity during breeding period.

•I.T.E.M.E.	Vaccinate calves 3 weeks prior to weaning and again at weaning.	Initial vaccine given upon entry to the feedlot; booster recommended 21 days later. Recommended more for 5-8 month-old calves.
Bacterial scours; enteric colibacillosis of calves	Pregnant heifers twice: 6 and 2 weeks before calving. Pregnant cows: 2 weeks before calving if they had the initial vaccination in previous years.	The initial vaccination in heifers can be given in the fall or winter period.

Beef cattle diseases

The control of disease and the prevention of deaths are important aspects of the management of beef cow herds. In the following discussion of diseases affecting beef cattle, a specific agent or factor is often given as the cause of the disease. It should be realized that an agent may not be solely responsible for the presence of the disease. Environmental, nutritional, genetic or other factors, or a combination of these may aggravate the effect of the agent. Clinical signs of disease are usually the result of the interaction of many factors.

Common diseases affecting cow-calf production are presented in this section. The diseases are organized on a calendar basis to follow one complete production cycle of the beef cow herd.

September and October

Blackleg

This highly fatal disease is caused by a soil-borne bacterium *Clostridium chauvoei*, which enters the body through the digestive tract or a wound. Usually fast growing animals between 6 to 24 months of age are affected, especially if they are on a high plane of nutrition, but all ages can be involved. The organism invades muscle tissue causing severe inflammation and systemic toxemia.

Few animals are seen alive with the disease; usually they are found dead. If affected animals are observed alive, severe lameness on the affected limb is characteristic with pronounced swelling (hot and painful at first, cold and painless later) with gas palpated under the skin. The skin on the affected limb later becomes dry and cracked. There is a high fever and severe depression.

Treatment consists of large doses of penicillin but is usually unsuccessful. Animals should be removed from the affected pasture and isolated. Deep burial or burning of carcasses is advised to minimize the contamination of the soil with spores.

Prevention is by means of vaccination, which produces good immunity but requires 10 to 14 days to develop.

Malignant edema

Clostrium septicum and other bacteria cause this soil-borne disease. They enter the body through puncture wounds, surgical wounds or parturition injuries that are contaminated with dirt. Unlike blackleg, all ages of animals can be affected with this highly fatal disease caused by the absorption of potent toxins from the site of infection into the blood stream (toxemia).

Clinical signs usually appear within 12 to 48 hours after infection and are characterized by swellings at the site of infection that are soft at first, and later become hot and firm and may contain gas. The animal is usually very depressed with a high fever and may be stiff or lame.

The best treatment consists of antibiotics administered early in the illness, but death often comes within 24-48 hours after disease is detected. As with blackleg, isolation of affected animals and proper disposal of carcasses is advised.

Malignant edema is prevented by a routine vaccination along with blackleg, and should be done at least two weeks before surgery such as castration and dehorning.

Infectious bovine rhinotracheitis(IBR)

IBR is a viral infection of the upper respiratory tract that primarily affects the internal structures of the nose and trachea (wind pipe). The virus belongs to the family Herpes. It is spread by the breathing in of contaminated droplets of moisture from affected animals The virus can exist in an animal in a latent form without causing any signs of disease. When the animal is put under stress in later life, the virus will be reactivated and may be spread to other animals. This is often the only explanation for an outbreak of disease in a herd that has been closed for some time.

Cattle of all ages are susceptible, but generally it is cattle over six months of age that are affected and show signs of a high fever, harsh cough, nasal discharge, watery eyes and loss of appetite for several days. Recovery is usually complete in one week but can be prolonged in feedlot cattle. Some animals may develop secondary infections such as pneumonia.

Abortions often occur following exposure of susceptible pregnant animals to infection. They can occur suddenly at any stage of gestation but usually in the last third of pregnancy, aborting animals do not appear sick.

An ocular form of IBR can occur in any susceptible class of cattle and usually occurs along with the respiratory form. The discharge from the eyes is clear at first then turns white and "mucus-like".

A genital form of IBR produces lesions on the penis that temporarily interferes with breeding. In cows and heifers, an inflammation of the vulva is seen that often results in a yellowish-colored discharge that persists for a few days. Recovery usually occurs without treatment.

Although the IBR virus is not affected by antibiotics, animals affected with the respiratory form of IBR should be treated with broad spectrum antibiotics to help control secondary infections like pneumonia.

Control of IBR is based on both vaccination and management. Three types of IBR vaccines are available in Canada, a modified-live (MLV) intramuscular vaccine, which *must not* be used on pregnant animals; a MLV intranasal vaccine, which is safe for use in pregnant as well as open cattle; and a killed intramuscular vaccine is also available for use in both pregnant or open animals. Both of the modified live vaccines give good protection against the abortion form of IBR, but variable protection against the respiratory form of IBR in feeder cattle. The IBR vaccines will not provide protection against other common diseases of the respiratory tract of cattle such as shipping fever, necrotic laryngitis or pneumonia.

It is not possible to make uniform vaccination recommendations that can be applied to every cattle herd. The recommendations made by a veterinarian will vary from one herd to another and from one area to another depending on the particular circumstances such as:

- time of year during which the problem is present
- origin of the cattle if purchased
- the disease history of the herd
- the kind of cattle threatened on the farm by the disease
- the vaccination history of the herd.

Some general vaccination recommendations are as follows:

- Vaccinate all breeding bulls one month before the breeding season.
- Depending on the type of vaccine used and the risk of exposure to IBR, once all breeding animals have been vaccinated, only the heifers and the bull replacements may need to be vaccinated on a yearly basis. The immunity obtained from the initial vaccination is often reinforced through natural exposure to the virus.
- Calves in a preconditioning program should be vaccinated three to six weeks before weaning. If vaccinating the calves with a MLV intramuscular vaccine before weaning, be sure the dams of the calves have already been vaccinated for IBR to prevent abortions from occurring after vaccinating the calves.
- Weaned calves and feeders should not be vaccinated during a period of stress.
- In the face of an outbreak of IBR, all pregnant cattle may be vaccinated, but only intranasal or killed vaccines can be used. Consult a veterinarian for vaccination recommendations.
- Some vaccines contain IBR and PI^3 viruses and others contain IBR, PI^3 and BVD viruses. These double and triple vaccines must be used with care because complications are possible. Professional veterinary advice should be obtained so that the disease history and expected incidence of disease in the herd can be evaluated.

Cattle breeders selling purebred stock internationally should be aware that some countries require imported cattle to be negative to any IBR blood test. This would be unlikely in vaccinated animals.

In a feedlot it is important to avoid exposing newly introduced cattle to other cattle in the lot before the new cattle have developed an immunity to IBR. Avoid "topping off" a feedlot pen when there have been some cattle resident in the pen for some time. Mixing pens of newly placed cattle with resident cattle in a feedlot is not advised. Try to keep "side by side" pens in a feedlot filled with cattle that have been on one feed for the same length of time.

Shipping fever

This disease is caused by the appearance of large numbers of Pasteurella organisms in the lung. The disease is initiated when stresses such as weaning, shipping, dehorning, castration, cold weather, or a combination of these stresses, compromise (weaken) the immune system and leave the animal open to infection. In many cases the stressed animal becomes infected by respiratory virus, which further lowers the respiratory system's resistance to infection by bacteria such as Pasteurella. Shipping fever is often complex of infection with a combination of disease causing viruses and bacteria. The organisms involved are spread by inhalation when animals come into close contact with affected cattle. This occurs with crowding or close confinement, such as when previously pastured calves are confined with animals from various origins.

Animals of all ages are susceptible, but usually calves between 6 and 24 months are affected. Signs include depression, weak cough, rapid shallow

respiration and being off feed. A clear discharge from the nose and eyes is seen early in the infection, which may become thickened and crusty after several days. At the start of an outbreak, up to 50 per cent of the affected animals may be found dead with no signs of the disease observed by the herdsmen.

The successful treatment of shipping fever depends on early detection and isolation of sick calves, and their prompt treatment with antibiotics or sulfonamides. The local veterinarian should be consulted to determine the choice of drugs to use in your area, as well as the proper dosage regimen. If more than 10-15 per cent of a group are affected with shipping fever, mass medication of the entire group may be necessary.

Cattle usually make a complete recovery if treatment is started early. If treatment is delayed, losses are higher and survivors are often unthrifty because of lung abscesses and adhesions.

Control of shipping fever requires good management and the judicious use of vaccines. Research is still being conducted into development of a vaccine for *Pasteurella hemolytica*, but vaccines for common respiratory viruses like IBR, PI^3 and BVD are available and consideration should be given to their use as part of an overall preventive program. Since vaccinations alone have been disappointing in the past, consideration should also be given to improving management systems. In preconditioning, the common stresses of weaning, castration, dehorning, branding, vaccinations and feed changes are spread over a period of time, reducing their cumulative effects on the calf. Delaying transportation of calves to markets for at least two weeks following weaning will also minimize the stress involved.

Atypical interstitial pneumonia (AIP)

This disease is also known as pulmonary emphysema or fog fever and is associated with a number of factors that include mouldy feeds, dusty hay, and moving cattle from a poor to a new or lush pasture in the late summer and fall and sometimes with other respiratory infections such as laryngitis. AIP is thought to be an allergic lung reaction; recent studies suggest that high levels of tryptophan in the forage cause the disease.

Animals may suddenly be found dead about one to two weeks after moving to new pasture. Other animals will have labored breathing, often through their mouth, with their head extended and frothing at the mouth. The temperature of the cattle is normal or only slightly elevated. Up to 50 per cent of the adult herd can be affected in an outbreak of fog fever, with high death losses. Animals eating mouldy or dusty feeds are usually affected on an individual basis, and the signs are less severe. The disease is progressive with poor response to antibiotic therapy.

There is no specific treatment for AIP and removal of the herd from affected pasture does not appear to have much influence on the number of animals that become ill. Exciting or chasing the affected animals should be avoided. If animals are removed from the pasture, move them slowly. Adrenalin or corticosteroids may provide temporary relief, but a veterinarian should be consulted as soon as possible. Often slaughter is the only method of salvage for severely affected animals.

Because the exact cause of the disease is still unknown, prevention is difficult. Moldy feeds should be avoided and dusty feeds should be moistened before feeding. Observe animals closely when they are moved to a new pasture. Rumensin may be an effective preventative if fed before and after moving animals to new pastures.

Bovine virus diarrhea (BVD)

BVD is a highly infectious disease of cattle that spreads very quickly through the herd by contact with infected animals and the ingestion of feed contaminated by manure or urine from infected animals. It is widespread in most cattle herds, appearing on a farm and then disappearing in subsequent years. The disease is usually subclinical, meaning clinical signs are not observed, but occasionally a severe fatal diarrhea will affect young animals between 6 and 24 months of age.

Whether an animal will die of the fatal form of BVD depends on whether it was exposed to a mild form of the virus before birth. A fetus exposed to the mild form of the virus 120 days or more before gestation may become a carrier of the mild form of the virus and show no signs of the disease. If it is exposed to the more severe form of the virus sometime between 6 and 24 months of age, a fatal diarrhea usually develops for which there is no treatment.

Occasionally a mild form of BVD is observed where a number of animals will have a mild diarrhea and fever but these signs are often not observed. The severe form of BVD is seen as a persistent watery diarrhea and is associated with sores in the mouth. Often there is inflammation of the eyes. Occasionally affected animals will be lame as a result of sores on their feet. Survivors of this form of BVD are rare and usually are unthrifty.

If infection strikes during pregnancy then abortions, still births, mummified fetuses, birth defects and normal calves that are carriers of the virus may be observed depending on the form of BVD virus present and the stage of pregnancy involved.

Laboratory assistance is required to confirm the diagnosis of BVD. Control is directed towards vaccination of all female breeding animals in an attempt to prevent infection of the developing fetus.

There are two types of vaccines available, a modified live (MLV) vaccine and a killed vaccine. The killed vaccine is safe to use on pregnant animals, but the MLV vaccine can only be used on

open animals kept completely separate from pregnant animals. A veterinarian should be consulted regarding precautions in using these vaccines.

Sleeper syndrome or ITEME

This disease is one of several caused by the bacterium *Hemophilus somnus*. It occurs in spring primarily among calves between 6 and 10 months of age kept in feedlots and occasionally in pastured animals. The peak incidence of ITEME is usually in December, January, and February. The organism is commonly isolated from the genital tract of mature cows and bulls. It is assumed to be spread by contact with infected animals.

ITEME is a very acute disease. Many times animals will not be noticed as being ill and will be found dead. Clinical signs include: muscular weakness or stiffness, high fever, inco-ordination and paralysis. Death occurs within six to eight hours after symptoms develop. A postmortem is required to confirm the diagnosis; this usually requires laboratory assistance to observe microscopic abscesses in the brain. Early treatment of affected animals is usually successful; however, animals not treated within a few hours of the onset of clinical signs may not respond to therapy. The outlook is poor for animals found down and unable to get up.

Once the disease has been diagnosed, all exposed animals should be checked every few hours to detect new clinical cases and therapy started quickly. In some situations, medicating the feed for calves may be of value and should be discussed with a veterinarian.

Several vaccines are licensed in Canada for the prevention of the sleeper's" syndrome. They may be beneficial.

November and December

Brucellosis (Bang's disease)

Brucellosis is a reportable disease that is under the jurisdiction of the Health of Animals Branch, Canada Department of Agriculture. It is caused by the bacterium, *Brucella abortus*, which can also cause a disease in humans called undulant fever. Susceptible animals can contract the disease by eating feed or drinking water contaminated with uterine or vaginal discharges, fetal membranes or fetuses passed from infected animals. Contact with membranes of the eye of a susceptible animal can also result in infection. The organism persists for long periods if protected from direct sunlight; freezing allows for almost indefinite survival. Usually the infection is brought into the herd by an infected animal. Once an animal has developed the infection, it becomes a permanent carrier.

Clinical signs observed in a herd with brucellosis include abortion, retained placentas and infection of the uterus. Following an abortion, cows often are infertile, which may become permanent. Some animals may have swollen knees. Bulls may develop swollen testicles and become infertile. Diagnosis of brucellosis is by means of tests to find the organism in blood, milk or aborted fetuses and fetal membranes. There is no treatment for the disease.

Control is accomplished by making sure that new additions to the herd are tested before arrival. If possible, the Brucella status of the herd and its area of origin should be checked with Health of Animals. All animals that test positive will be shipped to slaughter.

Vibriosis (Camplyobacteriosis)

This venereal disease is caused by the organism,*Camplyobacter fetus*. It is transmitted on the reproductive organs of cattle at the time of breeding. In a cow herd the symptoms observed usually include prolonged heat cycles, a drop in the conception rate that may last from two to six months or longer until the cows develop immunity, and a lack of libido in bulls caused by an excessive number of cows returning to heat. Abortions are observed occasionally.

The diagnosis is not easy to make and is based on herd history, multiple tests of vaginal mucous (a single negative test is inconclusive), isolating the organism from an aborted fetus or transmission tests using suspect bulls on virgin heifers. In the past, bulls were thought to be permanent carriers of the disease, but recent evidence indicates that a young bull can spread the infection from an infected cow to a noninfected cow, even when not infected himself. An infection will clear up on its own in young bulls that are rested from breeding. Older bulls, however, develop a carrier state that can be treated, but they are very susceptible to becoming reinfected.

Vaccines administered to the cows 30 to 120 days before the breeding season will prevent vibriosis. These vaccines are very effective when used on breeding females; however, immunity is not always reliable in bulls. Research to develop a reliable vaccine for use in bulls continues. Artificial insemination is another method of preventing the disease because semen is only drawn from bulls known to be negative for vibriosis.

Ergot poisoning

Ergot is an infestation of cereal grains, e.g., rye, oats, and grasses, by the fungus *Claviceps purpurea*. The toxic alkaloids cause constriction of the arteries when fed to cattle, swine or poultry. If the constriction is severe enough, the circulation to the lower parts of the limbs, ears, or tail may be completely shut off, resulting in the death of those tissues (gangrene).

Symptoms are lameness and gangrene of the extremities. Cows may have abortions.

Bloat

Bloat occurs when gas, a normal product of rumen fermentation, forms more quickly than it can be eliminated from the rumen. There are two types of bloat: free gas bloat and foamy bloat. In free gas bloat, there may be an obstruction of the esophagus, overfilling of the rumen, or a paralysis of the rumen so that the rumen does not contract properly. The result is an accumulation of free gas in the rumen that can be removed easily with a stomach tube.

On the other hand, foamy bloat is of dietary origin and can occur when animals are on pasture grazing legume forages. It also occurs infrequently when animals are consuming dry legume hay. Soluble proteins in the legumes are released in the rumen during fermentation and result in foam production that traps fermentation gases, preventing the animal from 'burping'.

Feedlot bloat is a form of frothy bloat that occurs when animals are on a high grain, low roughage ration. The cause of this form of bloat is thought to be related to a change in the fermentation in the rumen resulting in production of a foam or slime that prevents the normal elimination of the fermentative gases.

Clinical signs are obvious with distension in various degrees of the left side of the abdomen. The animal is nervous, kicks at its belly and often lies down and gets up again immediately.

Treatment depends on the form and severity of the bloat. Free gas bloat can be relieved quickly by passing a stomach tube into the rumen or by the use of a trocar passed into the rumen through the midpoint of the paralumbar fossa on the animal's *LEFT* side. Frothy bloat, on the other hand, cannot be relieved by use of a stomach tube or a trocar because the foam is too thick and viscous and will plug the tubes. If the bloat is severe, one may have to do an emergency rumenotomy. A knife is stabbed into the rumen on the animal's left side in the mid paralumbar fossa, and a cut is made into the stomach about two to three inches long. This will allow the foamy contents to be expelled under a great deal of pressure. This wound must then be cleaned up and any contamination of the peritoneal cavity removed. Following suturing, the wound usually heals very quickly. After-effects in these animals are often minimal.

If the frothy bloat is less severe, a stomach tube may be passed into the rumen and an antifoaming agent such as dioctyl, mineral oil or detergents can be pumped into the rumen. The foam will then break down and the gases can be released by normal burping. These agents can also be injected directly into the rumen using a needle through the left side of the animal in the mid paralumbar fossa area.

Some animals become chronic bloaters. In this case a screw type trocar can be inserted through the left side into the rumen and left there; good results have been reported. Animals that have been treated for bloat must be watched for several hours to make sure the bloat is going down.

Do not let animals graze a dangerous pasture early in the morning when the pasture is wet with dew; feed them dry nonlegume hay beforehand. The only reliable method of preventing pasture bloat is to add oils or fats as a drench to the grain mix or to the drinking water before the animals go out onto the pasture in question. Between 120 and 300 g per day of oil is required. Vegetable oils, mineral oil, or emulsified tallow can be used. Caution is advised when using mineral oil because it interferes with the absorption of carotene and tocopherol over a prolonged time.

Poloxalene, at the rate of 20 g per animal per day, fed in the grain or in a mineral block has also been beneficial in preventing pasture bloat, but it will not prevent feedlot bloat. Feedlot bloat is best prevented by adding chopped roughage to the grain at the rate of at least 10-15 per cent of the ration. Grains should not be ground finely, only rolled or cracked. The use of pelleted feed is not recommended.

Grain overload or rumen overload

Rumen overload develops when too much grain is provided too quickly before rumen microorganisms can adapt to the higher levels of carbohydrates in the ration. Excessive acid, produced from the fermentation of the large amount of starch, is absorbed into the blood stream and causes poisoning. Grain overload is a common problem in feedlots when animals are brought onto full feed too quickly, or when errors are made in the ration. Individual cases may occur where there is limited bunk space and an aggressive animal consumes more than its share of grain.

Depending on the form (whole versus ground) and the amount of grain consumed, signs may occur within 6 to 12 hours. Signs vary from the affected animals being off feed with soft feces to being weak and staggery with a bloated appearance. There is usually a profuse diarrhea and sunken eyes in more severely affected animals. Ill animals may go down and become cold and comatose with up to 50 per cent of the affected animals dying without treatment.

Treatment of this condition depends on many factors including the number of animals affected, the amount of grain consumed (if known), the value of the animals and the stage of disease affected animals are found in. Consult with a veterinarian as soon as possible to best handle the situation.

Mildly affected animals may not require any treatment other than the removal of grain from their ration for several days. More severely affected animals may require the administration of mineral oil and oral antacids with a stomach tube. If a large amount of grain was consumed by a limited number of animals remove the grain through a surgical incision of the rumen; however, if a large number of animals are involved, quick slaughter may be the best alternative. Consult

with the veterinary inspector at the intended slaughter plant. Intravenous fluids are beneficial for correcting the severe dehydration and acidosis that occur in these animals. The key to success in any outbreak of grain overload is to start treatment early. When large amounts of fermented material enter the intestines and start to be absorbed, the chances of successful treatment decrease.

To prevent grain overload, ensure bunk space is adequate, rations are properly mixed and feeder cattle are started on rations consisting of at least 60 per cent roughage mixed with grain. After 7 to 10 days, the amount of roughage can be gradually reduced by about 10 per cent every 4 to 5 days to a level of no less than 10 to 15 per cent of the ration. Cows fed grain should received no more than 2.27 to 3.63 kg of grain to start with; this can be increased by about 10 per cent every 4 to 5 days. Access should be provided to free choice roughage.

Liver abscesses

Liver abscesses can occur as a result of other infections in the body such as those caused by hardware disease, but usually they occur in animals fed a high grain - low roughage ration. The incidence of liver abscesses increases as the level of concentrates in the diet increases. Although the exact cause is unknown, it is thought to be the result of episodes of grain overload. The damaged lining of the rumen is then susceptible to bacterial invasion resulting in abscess formation in the liver. Feedlot cattle have the highest incidence of liver abscesses, but animals of all ages are susceptible.

No clinical signs are observed unless the liver abscesses spread to other organs in the body, such as the lungs. Feed conversion is reduced in feedlot steers with multiple liver abscesses.

Slaughter is a possible method of salvage if an animal has clinical signs related to liver abscesses since treatment is unlikely to be successful.

To minimize the incidence of liver abscesses, avoid sudden changes of diet, especially from a low to a high carbohydrate ration. Feed medicated with antibiotics (e.g., chlortetracycline 70 mg/head/day) can reduce the incidence of liver abscesses and buffered rations have also been beneficial but only in the early feeding period.

Sweet clover poisoning

This disease is caused by moulds growing on sweet-clover *Melilotus alba* hay or silage. The mould converts harmless coumerol in sweet-clover into toxic dicoumerol, which interferes with the normal clotting of blood. Animals fed mouldy feed may spontaneously develop fatal hemorrhaging, but usually excessive hemorrhages occur following castration, dehorning or calving.

Mouldy sweet-clover should not be fed to animals, if this material must be fed, it should be diluted to one part spoiled clover to three parts of unspoiled feed. Do not feed mouldy clover to cattle within two weeks of calving or performing surgical procedures on them.

Affected animals can be treated with injectable Vitamin K^3

Footrot

Footrot is a contagious disease seen all year round but occurs more frequently under wet and muddy conditions. Soil borne bacteria gain entry through abrasions of the foot caused by sticks or stones, or through wet conditions.

An open wound can develop between the toes, usually on one foot, and causes swelling of the tissues resulting in severe lameness. Although some infection will heal without treatment, many untreated cases progress into deeper tissues of the foot and result in permanent lameness.

Antibiotics or sulfonamides usually give good results but later stages of the condition may require washing the foot and scraping away the dead material on the wound. Astringent solutions (e.g., 5 per cent copper sulphate) may be of benefit.

Prevent footrot by providing good drainage in feedlots and putting concrete pads around feeders and waterers. Including chlortetracycline in feedlot rations has been beneficial. The value of feeding organic iodides is controversial. Some reports suggest that a zinc deficiency predisposes animals to developing footrot; therefore, adequate dietary levels of zinc should be maintained. Making cattle walk through a mixture of 4.5 kg copper sulphate and 45 kg slaked lime may also be of value.

Lumpy jaw (Actinomycosis)

These bacteria (*Actinomyces bovis*) gain access to the tissues of the mouth through injuries (e.g., tooth eruption, awns, foxtails) and localize in the bony tissues, usually the lower jaw. A hard, immovable swelling on the upper or lower jaw results, which gradually enlarges and eventually breaks open and discharges a granular pus. As the swelling enlarges, the affected animal has increasing difficulty with chewing and eventually can't eat.

Because of the bone involvement, treatment may only stop further development of the lesion. Occasionally, there is a slow regression of the condition, but the response to treatment is poor and slaughter should be considered. Antibiotics, iodides and isoniazid have all been used with variable results.

Early diagnosis and treatment is the best control for lumpjaw. Isolation of animals with discharging lesions is advisable. Avoid poor quality roughage.

Wooden tongue (Actinobacillosis)

This condition results in a hard swollen tongue that may protrude from the mouth. Excessive salivation and difficulty in chewing cause the affected animal to lose weight.

A bacterium, *Actinobacillus lignieresi*, causes the condition. It gains entry into the tongue through abrasions caused by barley awns, foxtails and other coarse materials.

Antibiotics or sodium iodide usually result in a rapid recovery, especially if treatment is started early in the course of the disease. Control is the same as for lumpy jaw.

January and February

Polioencephalomalacia (Polio)

This condition, which is unrelated to the human polio disease, usually occurs in well nourished cattle from 6 to 18 months of age that are on a high concentrate, low roughage diet. There is a sudden swelling and degeneration of the brain, which causes a variety of nervous signs including blindness, staggering and head pressing. Body temperature is usually normal. Some animals will go down and lie on their side making paddling movements and clamping their jaws. Death is common in animals that go down.

The cause of polio, is associated with an acute thiamine deficiency, probably caused by excessive destruction of dietary thiamine by the rumen micro-organisms. Injections with thiamine result in recovery if treatment is started early in the course of the disease.

Prevention is difficult because all the factors involved in causing the disease are not yet understood. An increase in the roughage content of feedlot rations is advisable, and adding thiamine to the ration may reduce the incidence of the disease. Occasionally polio occurs in pastured cattle; removal from the problem pasture is suggested.

Call a veterinarian any time animals show nervous signs. Because nervous diseases look alike, making a definite diagnosis difficult. Most nervous conditions can be treated successfully if diagnosed early.

Abomasal impaction

Wintering cows that are fed large amounts of poor quality ground or hammered roughage (e.g., straw) are susceptible to abomasal impaction. Frequently the grain or energy intake is low. In cold weather and during late gestation when the animals' nutritional requirement is increased, consumption of feed increases but the digestibility is poor. If the feed is allowed to pass to the fourth stomach (abomasum) before it has been properly digested by the rumen microorganisms, it becomes impacted in the abomasum.

The signs of impaction develop slowly and are often not noticed until one or two animals become weak and recumbent. The cows become sluggish, are off feed and have firm, scant manure. Sometimes a weak staggering gait is noticed before the cows go down in later stages.

Because treatment is futile in advanced cases, slaughter is recommended. Laxatives and mineral oil may help early cases. Good nursing care and shelter are required to aid recovery.

Ensure that the energy and protein content of the ration is adequate in cold, wet or windy conditions, and in the last trimester of pregnancy. Supplementation with grain is advised, especially for first calf heifers and thin cows. Avoid finely chopped roughages.

Water belly (Urinary calculi)

Urinary calculi are formed by the crystallization of mineral salts in the urine. Feeds high in silicates or with a low Ca:P ratio are commonly associated with water belly. Vitamin A deficiency may contribute to the condition as well. The small stones or calculi that form in the urine block the passage of urine through the penis.

Water belly occurs in steers and to a lesser extent bulls. It is characterized by stretching, stamping of the hind feet, tail switching and straining while trying to urinate. Complete obstruction of the urine flow will rupture the urethra (in the penis) or the bladder. A ruptured urethra causes a large swelling under the skin of the belly while a ruptured bladder results in accumulation of the urine in the abdomen, giving the calf a "bloated" appearance.

Slaughter is possible provided the urethra or bladder has not ruptured. If a rupture has occurred, surgery is the only method of treatment. It is much more successful if done early.

Late castration, adequate Vitamin A levels (30,000 IU/head/day), a Ca:P ratio of 1:1 or 2:1 and keeping calves intended for feedlots off high silicate content pasture are preventive measures. Adequate water supply and increased dietary salt (3-5%) may reduce the number of affected animals.

Coccidiosis

Coccidiosis is an acute or chronic disease caused by small single-cell parasites *Eimeria spp.* Animals acquire the parasites as eggs taken in with fecal contaminated food, water or soil. The parasites multiply in the gut lining, often causing serious damage. Many infected animals show no obvious signs of infection. One type of coccidiosis is seen in the summer and is associated with the normal development of the parasites. Another type of coccidiosis is seen in the winter and is thought to be brought on by stress. Young animals are the most commonly affected, whether on pasture, in feedlots or in housing.

Clinical signs include a bloody diarrhea, blood stained rear end, excessive straining, weight loss and dehydration with anemia and death in severe cases. Diagnosis of coccidiosis is done by examining the feces of an affected animal for oocysts (eggs) or by postmortem examination of dead animals.

Several drugs are effective against the parasite when it is still in the gut lining, but they must be given before or just as signs are observed. Good management and early diagnosis are important in reducing the losses associated with this disease. Consultation with a veterinarian is important.

Avoid stress, overcrowding and the contamination of feed and water supplies with feces. Several antibiotics to control coccidiosis are now available as feed additives for feedlot animals.

Mange

Mange is a highly contagious disease caused by very tiny mites that live on or in the skin. The infection spreads among cattle when they are in close enough contact for mites or mite eggs to move from one animal to another. Mange may also be transmitted via bedding, buildings, and feeders. Of the four types of mange that occur in cattle, only one, Chorioptic, is common in Canada. The other three are rare (Soroptes, Demodex and Sarcoptes). Infection is seen mostly in winter when animals are in close contact. Animals of all ages can be affected.

Chorioptic mange is most common around the feet, legs, tail and belly and produces irritation with weeping, scab formation, and self-inflicted injury. Sarcoptes mange is more common around the escutcheon and inside the thighs but may spread to the abdomen and neck, resulting in loss of hair from the skin that may be swollen with numerous small red spots and scabs.

The skin damage associated with mange is different from that caused by lice. Lice are much larger than adult mites and can be seen. Mange infections, however, can be confused with those of lice.

Consultation with a veterinarian may be necessary. A positive diagnosis of mange is only possible by examining tissue from a deep scraping of the lesions with a microscope.

Because mange is potentially a serious disease, *all suspected cases of manage must be reported to CDA, Health of Animals Division* - if in doubt, consult a veterinarian. Several drugs are effective in treating mange, but supervision of mange treatment in cattle is the responsibility of a federal veterinarian.

To reduce the spread of mange on a farm, avoid overcrowding.

March and April

Warts

The common wart of cattle is caused by a virus that enters the body through skin abrasions. It can be spread directly by contact with infected animals or indirectly on instruments such as hypodermic needles, ear taggers and tattooing equipment.

Warts appear as cauliflower-like lesions on the head and neck of affected animals but may spread over the entire body. Young animals are most often affected.

Treatment is not normally required since warts will disappear spontaneously in the majority of animals. Autogenous vaccines have been successful in some situations. Surgical removal may give good results, although an increase in the number and size of warts may occur on some animals following surgery.

Prevent warts by isolating infected animals and keep surgical instruments clean.

Ringworm

Ringworm, which is caused by several types of fungi, occurs commonly in animals housed close together for long periods of time. Young animals are affected more often than adults. The disease is spread either directly from animal to animal or indirectly by contact with contaminated bedding, stalls, or grooming equipment. Animals can carry spores in their hair without developing lesions.

A grey-white circular crust rising above the skin is commonly observed on the head or neck but may appear on any part of the body. These lesions are usually not itchy and clear up spontaneously.

Treatment is often unsatisfactory but does reduce the spread of the fungi to other animals. The lesion should be scrubbed with a stiff brush followed by the application of topical medications such as a mild iodine solution, Tinevet or Thiabendazole. Valuable animals may be treated orally with griseofulvin with good results. The conditions appears to clear up spontaneously when cattle are put on pasture.

To prevent the disease, ensure that animals are receiving adequate nutrition (especially Vitamin A) and isolate and treat affected animals. Contaminated pens or buildings can be disinfected with solutions of 2.5 - 5 per cent phenol, 0.25 per cent sodium hypochlorite or 2 per cent formaldehyde mixed with 1 per cent caustic soda.

Care should be taken when handling animals infected with ringworm because it spreads easily to humans. Wear gloves and burn all scrapings.

Hardware disease

Nails or other metallic objects swallowed by cattle may puncture the wall of the reticulum (first stomach). Acutely affected animals go off feed suddenly, move slowly and have pain in the area of the sternum. They are reluctant to urinate or defecate and the feces are usually drier than normal. Chronic cases of hardware are hard to diagnose; the animals often do poorly. There may be chronic bloat, engorgement of the blood vessels of the neck, swelling of the neck or brisket, or abnormal breathing.

Treatment of acute hardware disease includes elevating the front end of the animal about 25 cm

(10 in), administering a magnet and antibiotic therapy, and in some cases performing surgery to remove the foreign object. Animals with chronic hardware should be salvaged through slaughter.

Hardware disease can be prevented by installing magnets in milling equipment, administering magnets to individual animals and by cleaning up pastures, paddocks and hay fields.

Vagus indigestion

This condition is difficult to diagnose. It is caused by the damage to one of the nerves supplying the four stomachs, often as a result of hardware disease. Affected animals are poor doers, eat poorly if at all, and may appear full on the left side of the abdomen or very gaunt in other cases. There is no treatment. Salvage through slaughter should be considered.

Grass tetany

This condition to which lactating cows are susceptible is most prevalent in late winter or early spring. It is associated with lower than normal levels of magnesium in the blood stream rather than a single deficiency of magnesium. Various factors may be interfering with the absorption and metabolism of magnesium e.g., calcium, potassium, sodium or energy intake.

Affected animals are nervous and unusually alert. They are often belligerent and develop a staggering gait with muscle twitching. These animals finally become recumbent with their heads back, jaws champing and legs "paddling". There may be periods when they lie quietly, but a sudden noise or touch may cause another attack.

Animals treated early respond well to intravenous magnesium and calcium gluconate solutions. Animals treated in the late stages of the disease often fail to make a complete recovery.

If lactating cows are put out on lush pasture, a magnesium supplement such as magnesium oxide should be provided at a rate of 60 g per head per day. Ensure an adequate energy level in the diet and provide shelter during inclement weather.

Prolapsed vagina

Prolapsed vagina is a condition in cows where the hind part of the genital passage protrudes from the body, usually two to three weeks before calving. The exposed vagina becomes dirty and sore, causing the cow to strain and make the condition worse. The vagina is usually replaced and retained with sutures and the animal observed closely until calving. Such animals should be culled in the fall because the condition is likely to recur annually. There appears to be a genetic susceptibility to it.

Calf scours

Diarrhea in young calves can be caused by bacteria, viruses, protozoa or nutritional factors but is usually caused by a combination of these agents in association with stress on the animal in the form of cold or overcrowding. It is most common in calves under 10 days of age, especially in those that have poor colostral immunity.

The diarrhea varies in color and severity depending on the cause. Affected calves are usually depressed, weak and dehydrated, which is shown most dramatically by sunken eyeballs. Death can occur in a few hours but usually takes several days in severely affected calves.

Successful treatment of scouring calves requires early detection. Frequent vigilance of the herd is necessary. Consult a veterinarian for specific recommendations.

Identify and isolate scouring calves from the rest of the herd. This helps to prevent the spread of infection and to determine when a calf started to scour and how many times it has been treated. Always change coveralls and wash your hands and boots before moving to another group of calves.

Scouring calves should be treated with antibiotics. Antibiotics should be given by injection instead of by mouth. Continue administering them for at least three days to minimize relapses. Antibiotics are beneficial only when treating scours caused by bacteria such as *E. coli*, but it is often not possible to determine clinically whether the cause is bacterial or viral. As well, infections in calves are commonly mixed, i.e., bacterial and viral. The possibility that intestinal bacteria will enter the bloodstream is reduced if antibiotics are administered to affected calves.

The most important therapy for scouring calves is the replacment of lost body fluids and electrolytes such as sodium, chloride, potassium and bicarbonates. To assess the amount of dehydration present, observe the eyes (sunken) and the elasticity of the skin, especially the eyelids. In severe cases (calves that lie flat out and are unable to get up), fluids must be administered intravenously using sterile equipment and solutions. Careful calculation of the rate and volume of fluids is required; therfore, it is best if the electrolyte solution is administered by or under the supervi sion of a veterinarian.

Most scouring calves can be treated successfully using oral electrolyte solutions. Using a stomach tube, esophageal feeder or nipple bottle if the calf is strong enough to suck is simple and does not require sterile equipment. The equipment should be cleaned and disinfected after use on each calf. Commercial electrolyte solutions are readily available. Your veterinarian should be consulted to make sure you are using products containing adequate levels of electrolytes and glucose.

Depending on the size and degree of dehydration, up to four or five litres of fluids may be required to rehydrate a scouring calf. Extra fluid

will be required to replace the continuing loss of body fluids and electrolytes until the diarrhea stops. It is advisable to give two or three litres of fluid every six to eight hours until the diarrhea stops.

Restricting the milk intake of calves for 24 hours following the onset of diarrhea may be helpful in individual cases if the cow can be milked out and left with the calf. During outbreaks it is not practical to milk out the cows, and since separating the calf from the dam causes considerable stress, this procedure is not recommended.

Several commercial products that contain Kaolin and Pectin are available, however, they have not been shown to be beneficial. Some producers feed raw eggs, but this may be detrimental because young calves cannot digest egg protein. Table sugar is not recommended either, because calves are unable to digest it.

Scour prevention depends on many factors. Cows should receive proper nutrition throughout the winter to avoid calving difficulties and producing insufficient volumes of colostrum and milk. Poor cow nutrition can also result in weak calves that can neither stand to nurse nor survive extreme changes in weather.

The newborn calf, has two kinds of immunity; nonspecific immunity against infection in general, and specific immunity that protects against particular infectious agents. For maximum nonspecific immunity, a calf must receive a large amount of high quality colostrum soon after birth. By nine hours of age, an average calf will absorb only 50 per cent of the immunoglobulins in the colostrum that it would have if fed the same colostrum right after birth. At 24 hours of age, very little immunoglobulin in the colostrum can be absorbed by the calf. Calves that are weak following prolonged calving will often not nurse until 12 hours or later after birth at which time nonspecific immunity level will be greatly reduced.

First-calf heifers produce less colostrum than cows, and the colostrum may have as much as or 25 per cent lower concentration of immunoglobulins. Heifers generally mother calves less well than older cows. They also tend to have more calving difficulties than older cows resulting in weak calves, so it is little wonder that calves born to first-calf heifers often do not receive sufficient colostral protection.

Calves that are weak or unable to stand at birth require special attention. If they have not nursed within one or two hours, they should either be helped to stand and suckle, or the dam should be milked out and the calf fed by nipple bottle. Calves should receive a volume of colostrum at least equivalent to 5 per cent of their body weight before six hours of age (e.g., 1 litre for 50 lb of body weight). It is not necessary for a calf to receive colostrum from its own dam. Colostrum from high producing cows or from a neighbor's dairy cows may be stored frozen in plastic bags or containers until needed. Do not use the same nipple bottle or esophageal feeder for giving colostrum to newborn calves if it has been used for giving oral electrolyte fluids to sick and scouring calves. Clean and disinfect equipment after each use.

Environmental factors are important for preventing calf scours. The environment refers to the physical (e.g., climate, shelter, soil) and biological (e.g., other animals including man) factors surrounding individual animals in the herd.

The amount of usable space available to animals during the wintering and calving period may be one of the most critical factors determining the occurrence and severity of scour outbreaks. Severe crowding or crowding for long periods of time increases the contamination in the environment of the newborn calf. The build-up of environmental contamination becomes more severe as crowding increases. The amount of environmental contamination may become so high that it overwhelms natural colostral immunity and the protective effect of vaccines.

Crowding also increases the amount of stress on the animal, particularly newborn calves. Under crowded conditions, newborn calves may have difficulty finding and nursing their dams early and as a consequence may not ingest sufficient colostrum. When not nursing, newborn animals normally spend most of their time sleeping. However, when crowded, they may find it difficult to locate a quiet, comfortable resting place where they will not be trampled and buffetted by other animals. It is desirable to calve first-calf heifers in a separate area where they can be observed and assisted if necessary. Avoid situations where there is less than 185 m^2 (roughly 2000 sq ft) of available space per heifer. Cows should not be confined for calving if weather permits.

First-calf heifers and older cows should be wintered and calved separately. Each group has significantly different nutritional requirements because heifers are still growing. If the first-calf heifers and older cows are wintered together, the older cows will get more than their share of nutrients while the first-calf heifers will get less. The cows can become overconditioned resulting in more calving problems, poor colostrum and milk production and more breeding problems in the subsequent breeding season.

If cows and first-calf heifers calve together, the entire herd must be confined so that the heifers can be more closely watched and assisted at calving. This produces a higher density of animals in the calving area resulting in a build-up of infectious agents. The older cows may also interfere with the normal nursing pattern of calves born to heifers.

Calving inside barns, sheds and shelters increases the risk of scours even if calves are turned out before one day of age. Outbreaks of diarrhea frequently follow cold weather that is accompanied by wind and snow or rain. The specific

mechanism by which changeable or stormy weather affects the occurrence of scours is not known. Bad weather may increase stress and alter the nursing pattern of calves. Animals may also be crowded together as they seek natural or man-made shelter. During the 48 hours immediately preceeding outbreaks of diarrhea, the ground in calving areas is frequently wet. Excess ground surface water not only makes it difficult for calves to find a comfortable place to sleep, but also may transmit infectious agents. Conversely a dry, frozen or snow-covered surface may decrease the amount of contamination.

Ground surface water is present during the spring thaw or following spring storms, and is often worsened by improper location of calving grounds; low areas with improper drainage should be avoided.

It is impossible to recommend specific management procedures that are applicable to all situations because of the differences in herd size, availability of facilities and labor, and general management techniques. There are, however, some broad management principles that producers should attempt to adapt and integrate into their operations:

- Supply an adequate winter ration.
- Locate calving grounds carefully.
  - Do not winter and calve on the same ground.
  - When calving on range, locate calving grounds where there is some natural shelter and a windbreak. If semiconfinement calving is necessary, be sure some high ground with good drainage and a southerly exposure is available. Avoid low-lying areas
  - Avoid calving on the same ground year after year, particularly if you have previously experienced scour problems.
- Prepare and maintain calving grounds properly.
  - Monitor snowfall throughout the winter and anticipate excess snow build-up. Begin snow removal early during the winter. Plough strips 6-7 m (20-25 ft) wide at least once before the onset of calving, and clear spaces which can be used for feeding and loafing areas. Cleared areas should have a southerly exposure and be on elevated ground to avoid accumulation of water when snow melts.
  - Turn cattle into these areas as soon as weather permits and place feed and water in a manner that will encourage cattle to disperse.
  - Provide clean, dry bedding regularly so cows' udders and underbellies stay clean and to ensure calves have a dry comfortable place to sleep.
  - If one section of the maternity area becomes contaminated, or drainage is poor, fence it off until conditions improve. As more ground becomes bare, increase the amount of space available to animals.
- Avoid overcrowding and prolonged confinement during both wintering and calving periods.
  - Do not calve heifers and cows together.
  - Whenever possible, calve in the open and divide the main herd into smaller groups. If scours occurs in one group, avoid carrying contamination to other groups.
  - If semiconfinement is necessary, reduce population density in the immediate calving area. Do this by dividing the main herd into smaller groups based on anticipated calving dates or by rotating expectant dams through the calving area. Disperse calved out animals as soon as weather permits. In addition to decreasing population density, calving and dispersing calves in groups is believed to greatly reduce stress.
  - Avoid the use of barns or sheds for prolonged periods.
  - Provide at least 185 m^2 (2,000 sq ft) of calving space per heifer, i.e., no more than 20 heifers per acre.
- Minimize stress on newborn calves. Much of the damaging stress that often affects newborn calves can be removed by:
  - preventing overcrowding.
  - supplying clean, dry bedding.
  - providing access to natural or artificial shelter when the weather is bad.
  - providing proper wintering rations to ensure that cows and calves are strong at calving and that calves receive adequate colostrum of high nutritional and immunological quality.
- Provide extra care for weak calves.
  - A weak calf that develops scours may be the start of an outbreak; therefore, check calving cows and heifers regularly and provide assistance when needed.
  - Provide a sheltered area where assistance may be given.
  - If a weak calf is born, help it to stand and nurse early or be sure it is fed colostrum by nipple bottle or stomach tube.
  - Separate weak calves from the herd for several days to be sure they are healthy.

Navel ill

Navel ill is caused by bacteria that enter the body through the unhealed umbilical cord. The navel becomes hot, swollen and tender. A fever is often present and the calf may refuse to suck. If the condition progresses, the joints become swollen and painful and the calf will refuse to get up. Scours, dehydration and depression may accompany navel ill.

Treatment includes administering antibiotics by injection and cleaning the navel thoroughly.

Navels may be disinfected at birth with tincture

of iodine but the most effective preventative measure is to calve cows in clean surroundings. Ensure the calf receives at least two litres of good quality colostrum within two hours of birth.

Calf diphtheria (Necrobacillosis)

Necrotic stomatitis (a sloughing infection of the tongue) can occur in young calves less than three months of age, whereas calf diphtheria tends to occur in older calves and yearlings. The same bacteria cause both conditions. They are thought to gain entry through abrasions in the mouth or larynx (voice box).

Calves with necrotic stomatitis have a fever and are depressed and unable to suck properly owing to the presence of one or more large ulcers in their mouth. These can occur on the tongue or in the lining of the gum or cheeks. Feed often packs into these ulcerated areas and the breath has a foul odor. Other symptoms are excessive salivation and a protruding tongue.

Necrotic laryngitis, the calf diptheria form of the disease, causes ulcerations in the lining of the larynx with swelling of nearby tissues. This results in a loud snoring noise when inhaling. Coughing and swallowing are painful. The throat area is swollen and painful when touched. Excessive salivation is common along with a nasal discharge. Most calves will have a high fever and foul breath.

To get a good response to therapy and avoid serious complications, early treatment is important. Sulfonamides, penicillin and tetracyclines all give good results. Calves with severe necrotic laryngitis may require surgery (tracheotomy) to prevent asphyxiation and allow the larynx to heal.

Calves suffering from other diseases or nutritional deficiencies or calves kept in unsanitary, overcrowded conditions are more susceptible to necrobacillosis. Consequently, to minimize this condition, good feeding and management are essential.

Viral pneumonia of calves

As the name implies, this form of pneumonia is caused by a virus. Several different viruses may be involved in an outbreak of viral pneumonia and complications by bacteria are common. Calves from two to six months of age are the most susceptible. Predisposing factors include overcrowding, high relative humidity, draftiness and malnutrition. Insufficient colostrum after birth may lead to an increased susceptibility to pneumonia in calves at four to eight weeks of age.

Viral pneumonia usually occurs as a herd problem with individual animals that have high fevers, nasal discharge, rapid respiration and a dry hacking cough. Most calves will recover spontaneously in four to seven days if there is no secondary bacterial invasion. If bacterial invasion occurs, the death losses will be high without antibiotic therapy. Antibiotics are ineffective against viruses.

Good management is important in controlling viral pneumonia. Avoid overcrowding and provide adequate shelter and good nutrition for calves. Ensure newborn calves receive at least two litres of colostrum within the first two hours of life and a further two litres within the next six to eight hours.

White muscle disease (WMD)

White muscle disease is most common in areas where there are low levels of selenium in the soil, particularly Grey Wooded soils. The cause of the disease is a deficiency of selenium and/or vitamin E, although the exact relationships of these substances to WMD is not completely understood. Vitamin E deficiency is seen when the ration consists mainly of poor hay and straw. Green hay and grains are good sources of vitamin E. Because rancid fat destroys vitamin E, prepared rations that are supplemented with oils and fats should be fed when freshly mixed and not stored for more than a few days. Unaccustomed muscular activity, such as when calves are turned into pasture after barn confinement, often precipitates WMD in borderline cases of vitamin E deficiency.

Skeletal or heart muscles may be affected. Symptoms are related to the dysfunction of these organs. Affected calves may be weak or die suddenly after exercise. Muscles are often hard or swollen. There may be knuckling of the joints or trembling of the limbs. Difficulty in swallowing or abnormal breathing is occasionally observed.

Treatment consists of administering oral or injectable selenium and vitamin E preparations.

Control is based on avoiding diets deficient in selenium or vitamin E. Supplementing the diet with 0.1 to 0.2 parts per million (ppm) of selenium or feeding 1 gram of alpha-tocopherol daily to cows before calving is recommended in areas where WMD is a problem. In such areas, routine injections of selenium and vitamin E are given to calves at birth.

May, June, July and August

Spondylitis

This condition is a form of arthritis resulting in new bone proliferation in and around the spinal nerve. This puts pressure on the spinal nerves causing paralysis of the hind quarters.

It is seen in older, overweight bulls that have been used primarily for breeding on rough pasture. Weakness or paralysis of the hind legs of a bull may develop slowly or appear suddenly. The bull may appear "drunk" on the hind legs only.

There is no treatment for this condition, and the

only preventative measure that can be suggested is to avoid keeping bulls in an overfat condition.

Pinkeye

This common and costly disease is caused by a bacterium, *Moraxella bovis*. Other organisms may predispose the eye to infections of *M. bovis*. Stress factors are also important in the occurrence of this disease. They include excessive ultraviolet sunlight, eye injuries, vitamin A deficiency and irritation from the common face fly. The disease can be spread by contact with infected animals or by face flies that have come into contact with infected secretions from the eye, nose or vagina.

Affected animals have an excessive discharge from one or both eyes as a result of inflammation of the eye linings. As the condition progresses, the cornea (surface of the eye) becomes cloudy and ulcers may form in the centre of the eye. Exposure to light is very painful and the animal will often close the affected eye. Weight gains or milk production drop significantly in affected animals.

Early treatment of pinkeye is important for achieving a rapid recovery. Antibiotic ointments are helpful but must be applied to the affected eye several times a day. Sprays and powders should be avoided because they cause additional irritation of the already sore tissue. They result in excessive 'tearing', which quickly washes the drug out of the eye. Injection of the eyelid with penicillin and corticosteroids usually gives a good response. A veterinarian should be consulted on the proper method of performing this treatment.

Advanced cases of pinkeye can be confused with malignant growths (cancer eye) that require surgery to cure. Remove affected animals from direct sunlight to reduce the irritation of ultraviolet radiation. Eye patches can also be used for the same purpose.

The only means of preventing pinkeye is to control the face fly population, reduce dusty conditions, and ensure that vitamin A levels are adequate. Affected animals should be separated from the main herd because they can be carriers of *M. bovis* for several weeks after recovery. Vaccines are available and appear beneficial in some situations, but their effectiveness is still questioned.

Tetanus (lockjaw)

A soil born organism, *Clostridium tetani*, causes this condition. Spores are introduced through wounds and locate in the animal's tissues. Toxins are produced which irritate the nerves supplying muscles which then go into spasms. Tetanus affects all animals, including humans.

In cattle, tetanus is often associated with castration wounds or injuries of the birth canal following calving.

The first signs noticed in cattle is a stiff gait. Later, severe muscle spasms occur, which may be brought on by a sudden noise or movement. Death occurs from nerve damage and/or failure of the muscles of respiration (breathing).

Treatment includes tranquilization by putting affected animals in a quiet darkened stall using antitoxins and antibiotics and, of course, cleaning and disinfecting of the wound. Nursing care is important; food should be palatable and easy to swallow.

Prevention includes being careful at the time of surgery (castration) or calving, and removal of puncture wound hazards (nails). A vaccine is also available.

Lead poisoning

Some of the more common sources of lead are: lead-based paints, storage battery plates, used grease and crankcase oil from gas motors, linoleum and roofing paper, window putty, plumbing and caulk. In most cases animals gain access to sources of lead through negligence.

Symptoms of poisoning appear from a few days to two weeks following exposure to lead. Younger animals are often more severely affected than older ones. Cattle will show a number of the following symptoms: decreased appetite, transient constipation followed by diarrhea, abdominal pain, grinding of teeth, abdomen tucked, walking in circles, pushing the head against objects, twitching of ears, bobbing of head and lack of muscular coordination. Most animals appear depressed but become very excited especially when disturbed and may undergo convulsive seizures.

Lead poisoning at times looks much like **rabies**, so handle such animals carefully and seek help from a veterinarian immediately.

A tentative diagnosis of lead poisoning may be made on the basis of history, symptoms, and postmortem examination. In the postmortem, varying degrees of gastroenteritis and degenerative changes in the liver or kidney may be seen. Chemical analysis of blood from live animals or the kidneys, liver, or bones of dead animals is used to confirm lead poisoning.

Organophosphates and carbamate poisoning

These insecticides are used in many products. Some are applied to the backs of cattle to kill grubs and are quite safe when used in accordance with the manufacturer's instruction. Others are used for a wide variety of purposes in agriculture and can either contaminate cattle foodstuffs or may be eaten if they are not stored away safely. When absorbed or ingested in toxic quantities, they act on the nervous system in various ways.

Symptoms of poisoning with organophosphates or carbamates include: initial excitement, difficulty in breathing, profuse salivation, sweating, tears, urination, bluish gums, colic and

sometimes diarrhea, muscular twitching, staggering, paralysis, depression and death.

Organochloride insecticide poisoning

This group consists of compounds such as DDT, kelthane, methoxychlor, lindane, aldrin, dieldrin, endrin, chlordane and heptachlor epoxide. The use of these compounds is decreasing because they persist in nature for a long time (in some cases several years). Some of them are suspected of promoting cancer. Furthermore, their long life tends to create unacceptable levels of residues in the meat and milk from treated animals.

Cases of pesticides poisoning are often associated with accidentally giving animal an overdose or mistaking a pesticide for a feed or mineral mixture. Occasionally, stored feed has become contaminated with poison as a result of improperly stored pesticides. There have also been cases where cattle were poisoned by feed grain that was handled by a grain auger previously used for pesticide treated seed.

In cases of acute poisonings, some animals become apprehensive, hyperexcitable, wander aimlessly, try to jump imaginary objects, stumble into objects, make chewing movements continuously causing foaming at the mouth, stay in abnormal postures and have muscle twitches which may progress into convulsions interrupted by periods of depression. Coma and death may ensue.

Diagnosis is made with the help of history, symptoms and chemical analysis of liver, kidney, stomach contents, fat and hair.

Treatment consists of relieving the symptoms and preventing further exposure to the poison. A veterinarian should be consulted for details on treatment for the specific pesticide involved.

Products from contaminated animals are likely to contain unacceptable residues of the pesticide for a long time. Therefore, advice from the veterinarian and the federal and provincial authorities must be taken for disposal of such animals and their products.

Ammonia and urea poisoning

Urea and many ammonia derivations are substitutes for natural protein in ruminant feeds. If not used properly, they can be lethal poisons instead of nutrients. Urea is recommended in ruminant rations at a rate of no more than 3 per cent of the grain ration or about 1 per cent of the total ration.

Ruminants suffering from malnutrition, or disease or those not used to having urea in their feed do not tolerate urea well.

Arrow grasses

Seaside arrow grass, *Triglochin maritima*, and Marsh or small arrow grass, *Triglochin palustris*, are herbaceous, perennial, grass-like plants 15 to 76 cm (6 to 30 in) tall that are common in damp soils, marshes and sloughs, where the soil is alkaline or the water is brackish.

Arrow grass starts growing earlier in the spring than true grasses and regrows more rapidly than grasses after cutting. Arrow grass is more dangerous at these times because of its availability. Livestock will eat it readily at all times because of its salt content. Hay containing arrow grass gradually loses its toxicity with time.

Water hemlock (cowbane)

It is considered the most poisonous plant in North America. Water hemlock is a member of the family Umbelliferae (carrot family) and has leaves with serrated edges and veins proceeding to the edge of the leaf. It is found in wet places; stands of water hemlock tend to persist from year to year in the same spot. The thickened root system stores the food reserves for the plant and is the most useful feature in distinguishing the plant. A pungent oil in the root system changes from yellow to red within a few minutes of exposure to the air. The bundle of roots resembles those of dahlias with hollow internodes and diaphragms of pith tissue across the cavities.

The highest concentrations of toxins are in the roots and rootstocks. Symptoms develop within 15 minutes of ingestion of water hemlock and include violent convulsions, salivation and diarrhea (if a cow survives acute phase). Death is from asphyxia.

Algae poisoning

The accumulation of algae on water is called a "bloom" and consists of one or two of several types of algae that can cause poisoning. Its toxicity can change fairly quickly. The formation of a toxic bloom is dependent upon several factors. A steady gentle wind, warm water temperature, the presence of large quantities of organic matter in the water (feedlot run off or fertilizers) and a lack of water flow all contribute to the development of a toxic bloom.

Several toxic compounds may be produced. The degree of toxicity is related to the amount of toxins consumed by cattle as well as the species of algae involved. Death occurs within 1-48 hours after ingestion of the algal bloom. The signs of acute poisoning are acute death, tremors, staggering, convulsions, abdominal pain, diarrhea and difficult breathing. A chronic form of the disease is reported to cause liver damage that results in jaundice and photosensitization (peeling of light colored skin).

Treatment of affected animals is usually of little value. Algal growth has been controlled by adding copper sulphate to dugout water. Little can be done to control algal growing in larger bodies of water (e.g., sloughs). Preventing access to sloughs

may be the only practical preventative measure available.

Nitrates and nitrites

Nitrate toxicity comes most commonly from plant and water sources. The accumulation of nitrates in plants is greatest in the stalks. Fertilizers, (e.g., ammonium or potassium nitrate), are sources of nitrates to both plants and animals. Water draining from manure piles and nitrate fertilized soils draining into dugouts can be a source of poisoning.

Ruminants easily convert nitrates into nitrites, which are quite toxic. The nitrites oxidize the blood hemoglobin to methemoglobin, which is then not available to transport oxygen.

Poisoning usually occurs within hours of ingestion. Symptoms include rapid breathing, slobbering, muscular weakness, abdominal pain and muddy discoloration of the mucous membranes and whites of the eyes. If the intake of nitrates is high, the animal will die after a brief coma. On occasion, symptoms are not apparent until four to five days after ingestion of nitrates. The symptoms in these cases include unthriftiness, increased susceptibility to illness and a failure to conceive.

Internal parasites

Gutworms

Gutworms are associated with acute or chronic diseases. Animals ingest the larvae (immature parasites) with food, usually pasture grass. Once they are eaten by the animal, these larvae migrate into the lining of the gut then return to the cavity of the gut where they become adults. Under ideal conditions the whole cycle, adult to adult, takes about one month. Many infected animals show no obvious abnormalities. The effects are most important among young animals on pasture, but may also be seen in adult cattle and in housed and feedlot animals.

Affected animals show depressed production, loss of condition and may be off feed. Scouring, dehydration, anemia or edema are usually seen only in acute cases.

Several anthelmintics (wormers) are effective against adult parasites but not against immature forms in the gut lining. These wormers are there for only used for acutely affected animals where the adult parasites are present in the gut.

Supportive treatment for severely affected animals is important, e.g., good nutrition and adequate shelter.

Control measures will vary from farm to farm. Consult a veterinarian. Avoid overcrowding animals of mixed ages on areas where there is inadequate grass. Older animals are the main source of infection for young stock. Parasite eggs and larvae probably do not survive overwinter in significant numbers on pasture in the prairie provinces.

Preventive use of anthelmintics in the prairies is rarely needed to prevent acute disease, but their use may lead to increased production.

Lungworm

Lungworm is an acute or chronic infectious disease caused by the parasite *Dictyocaulus viviparus*. Animals acquire the infection as larvae (immature parasites) taken in with their food, usually pasture grass. The larvae come from the manure of infected cattle. Once they are eaten by an animal, they migrate through the lung where the adult worms live in airways. Many infected animals show no obvious abnormalities. Disease is usually seen in young stock towards the end of their first season on grass. It may also occur in feedlot or housed animals.

Signs include a persistent cough, difficult breathing, poor feed consumption, loss of condition or scouring in early stages. There may be a fever if secondary infection by bacteria or viruses occur in the lung. Some animals may die from lung worm infection. Live larvae may be observed in fresh feces. Adult worms are relatively easy to see in the windpipes of dead animals.

Some anthelmintics will kill both immature and adult parasites. Treat all animals in the affected group. Affected animals may require antibiotics if there is much lung damage.

This condition often appears on a farm year after year, especially if there are sloughs in the pastures. Parasite larvae are unlikely to survive overwinter on pasture in Alberta. Older animals are the main source of infection for young stock and should not be put on the same pasture as young stock.

Nursing sick animals

Although there are many powerful and effective drugs available, it is important to realize that medication alone will not produce as rapid or as complete a recovery as will be the case if simple nursing procedures are followed as well.

Disease in itself is stressful. Fever causes stress. Loss of appetite and subsequent lowering of energy reserves can contribute to stress. Fluid loss in diarrhea causes serious heat loss from the body and this causes stress. Therefore, other conditions such as cold, excitement or distress should be minimized as much as possible with sick livestock. This is a basic principle of animal nursing.

Cold

Extremely low temperatures can adversely affect the rate of recovery of a sick animal. Generally, a hardened animal will have grown a sufficiently thick coat to handle all but the lowest temperatures. It is a mistake to bring such an animal into a warm atmosphere, although in subzero temperatures a sick animal may be confined at a temperature a few degrees above freezing. For short periods in extreme illness, a quilt made of several gunny sacks sewn together filled with loose hay is useful. As the need becomes less acute the hay may be removed from the sacks and finally the sacks themselves may be removed.

Thick straw bedding protects the body from heat loss to the ground, for it must be remembered that the sick animal will spend much time lying down.

Moisture

Moisture such as melted snow or rain penetrates to the skin and destroys the insulation of the hair coat, lowering body temperature as the moisture evaporates. When there is risk of rain or snow, a sick animal must be housed under cover.

Wind

Currents of air are a serious cause of reduced body temperature, and therefore complete protection from the wind must be provided for sick animals. Temporary shelter can be constructed by using straw bales as walls, topped with poles, plywood and more straw bales.

Heat

Hot weather can be disturbing to the sick animal. Shade and good ventilation are required.

Isolation

Isolation is, of course, an important disease control measure. Isolation in a place free from stress, (e.g., in a location away from noisy children or a barking dog) will reduce anxiety in the animal. Try to avoid loud noises when treating such animals, particularly animals that are not adjusted to confinement.

Feed and water for the sick animal

Sick animals tend to slobber in drinking water and on their food. Both food and water develop an odor unpalatable to the animal. Water should be changed often and food offered in small amounts and then discarded. As the animal starts to recover, feeding may be encouraged by placing wisps of sweet hay in the animal's mouth. Fresh grass, such as lawn clippings, may be offered in handfuls; in winter a small amount of household vegetables may stimulate an interest in food. Sick animals appear to have a reduced ability to taste and offering a little food at frequent intervals seems to be a profitable course.

When animals are clearly weakened through lack of feed, old-fashioned remedies may be considered such as a litre of warm milk water containing 200 g (0.5 lb) of glucose or corn syrup and a 15 mL of powdered ginger. Giving this material as a drench must be carried out with extreme caution to avoid the animal taking any of the material into its lungs.

Care of the downer animal

Animals invariably seem to go down in unsuitable or inconvenient locations. For short distances, say 3 m (10 ft) or so, an animal may be slid along on its side on a layer of dry straw. Traction should be applied to a halter and to a rope attached to the under forelimb. A rope around the hind quarters can also be used to give assistance. For transportation over longer distances, a skid must be provided or a field gate may be used. The apparatus should be covered with a tarpaulin and straw, and the animal rolled onto the skid on its side. The head should be tied down and the entire load hauled away by tractor. Care must be taken that ears and tail do not get caught between the skid and the ground.

Downers must be given protection from the elements. Hard slippery floors must be avoided and the location must be well drained. A base of damp bedding (manure pack) about 225 mm (9 in) thick should be covered with an equally thick layer of dry bedding. Many downer animals could rise if they had good footing but fail to do because they lose the will to try when the floor is slippery.

A weak animal will tend to lie continuously on one side. The weight of the body will tend to compress the blood vessels, nerves and muscles of the lower limbs and reduce their functional status. A downer animal must be turned every three hours, day and night.

Moving a bulky animal from side to side can be a near impossible task for two men. However, a 3 m (10 ft) rope can be of assistance if it is drawn under the body by "sawing" forward under the buttocks. One end may be applied around the lower foot and the other end pulled over the body. This technique enables one person to roll an animal quite easily.

The Administration of Drugs

Injection

Equipment

Disposable syringes are widely used; if reused they should be chemically sterilized between use. The same applies to needles. Blunt needles should not be used. It is important to remember that some diseases can be spread by an infected needle and that a contaminated needle can cause abscesses. Store needles in a container of sterilizing agent and change needles frequently.

Before filling a syringe, the cap of the bottle should be cleaned with a sterilizing agent and a sterile needle inserted into the bottle. This needle should be left in place and all syringe filling should take place via the needle. This avoids contaminating the material to be injected. Air equal to the amount of fluid dose should be injected into the bottle. The pressure thus created will fill the syringe more or less automatically as the bottle is inverted.

Subcutaneous injections

Medication placed under the skin is absorbed slowly over a long period. If the medication is an irritant, there is considerable likelihood of reaction, swelling and possibly the formation of an abscess. The ideal location for a subcutaneous injection is at any point where there is loose skin over a moving part, at a site that is accessible but not dangerous for the operator. The skin over the shoulder blade meets these specifications admirably, although the neck is used by many. The loose fold of skin in front of the brisket is often used and so is the skin over the chest near the elbow.

The best needles for use in cattle are from 13 mm to 19 mm long and from 16 to 18 gauge. The skin should be picked up between the forefinger and thumb and the needle thrust in to its full depth parallel to the underlying structures, making sure that the tip of the needle doesn't lodge in the skin itself, thus blocking the opening of the needle.

Intramuscular injection

Intramuscular injections are absorbed relatively quickly and must be given into heavily muscled masses away from bones and joints. The limb and thigh muscles are usually used.

The needle used should be of 16 to 18 gauge and 25 mm to 38 mm in length, varying with the size of the animal. To insert the needle, first remove it from the syringe, then grasp the butt of the needle firmly between the thumb and index finger and stab the needle sharply into the selected site. The syringe should be attached to the needle and the plunger slightly withdrawn; if blood appears, the needle must be relocated. The injection should be made slowly because it can be painful if given rapidly.

Intravenous injections

Injections made directly into the blood stream start to act immediately; however, the procedure is accompanied by risks, the seriousness of which depends on the type of drug being administered. Farmers are advised to seek veterinary advice before attempting to follow this route.

Sub-conjunctival injections

In serious cases of pinkeye, the introduction of drugs into the conjunctiva that lines the upper eyelid has considerable value. Fine needles 13 mm long are best for this purpose. With the head rigidly restrained, the lining of the upper lid may be rolled outwards with upwards pressure to the eyelid; the needle is then inserted beneath the pink membrane. It should be noted that the needle will be passing close to sensitive structures of the eye, so it is advisable to have a veterinarian demonstrate this technique.

In drinking water

Animals will normally refuse drinking water containing medication. If only medicated water is

available and if the concentration of the medication is not too high, certain preparations may be given in this manner. The method, however, is only of value in preventative therapy for large numbers of animals.

Drenching

The art of drenching lies in allowing the animal time to swallow. Usually 750 ml bottles are convenient drenching vessels, however, it is essential to attach a 250 mm tube to the mouth of the bottle to avoid the risk of the bottle breaking in the mouth. Old milking machine liners or a length of hose are quite adequate. With the animal restrained in a stanchion or chute, the operator should stand on the left side of the animal's head and place his/her right hand on the side of its nose below the eyes. The hand should then be slipped into the mouth and the upper jaw held by the dental pad (the toothless upper jaw). The animal will then open its mouth automatically, allowing the operator to slip the tube inside its left cheek. *Do not* elevate the head more than a few degrees above horizontal. *Do not* hold the bottle too high so that the mouth is flooded. During this procedure, the animal will chomp and swallow and thus should drink the medication a little at a time.

Stomach tubing

The stomach tube may be used to relieve bloat and to administer large quantities of fluid. The tube should be 13 mm to 19 mm in diameter with a thick firm wall and it should be about 2 m (6 ft) long. For calves, a human enema tube or special esophageal feeder should be used. Calves have particular needs for colostrum and electrolytes in respect to the treatment of calf scours.

For adult animals, it is best to place a tube guide in the mouth. This is a wooden bar with a hole in the middle. The presence of the guide prevents the animal from chewing the tube and stimulates a swallowing action.

With the animal adequately restrained, the tube is inserted into the mouth. Use gentle pressure. If there is little or no resistance, the tube has probably gone into the trachea and breathing will be heard via the end of the tube, also the tube will not go so far into the animal. If the tube has passed into the rumen the odor of rumenal contents will come up the tube. If still in doubt, one may blow down the tube and listen in the area of the last rib on the left side for a bubbling sound. The tube on passing down the neck may be palpable from outside, it will penetrate the body further and more resistance will be felt than when it is in the trachea. Coughing is a sure sign that the tube is in the wrong place. Pumping fluids directly into the lungs will *kill* the animal. The use of the stomach tube is not recommended unless the operator has been thoroughly trained in the procedure.

Balling gun

Many medications may be made up as capsules or boluses, all of which may be administered by a balling gun. Magnets may be given in the same way.

Again, good restraint is important. The balling gun should only be placed over the prominence at the back of the tongue before the ball is released. If used incorrectly, a balling gun can inflict serious injury to the mouth or throat tissues.

Medications in the uterus

Taboles

The value of placing anything in the uterus after calving is doubtful, to say the least, and it is likely that infection will be introduced.

The operator *must wash* the vulva with disinfectant solution and *must* use a new disposable plastic glove for *each* animal treated.

The taboles should be well separated in the uterus and placed as far forward as possible.

Uterine infusion

This technique should not be attempted by inexperienced operators.

Topical medication

Topical medication is medication applied to the external surface of body, as would be the case in treating ringworm, lice, wounds or pinkeye. When extensive topical medication is applied, such as for warble control, the manufacturer's instructions must be followed and the operator should wear protective clothing.

Intramammary medication

Prior to treatment, the udder should be completely milked out into a bucket containing a little disinfectant. Milk from a mastitic quarter is infected and the infection can be easily transmitted by flies or on the hands.

The teat end should then be disinfected and the medication should be infused. The quarter then should be massaged to distribute the drug.

Pests of Beef Cattle

Insects

Insect pests are encountered all year round in livestock operations. For profitable livestock production an effective pest control program is a must. Each year insects take their toll of profits through reduced weight gains, decreased milk flow for the nursing calf, damage to hide and meat, disease transmission and even loss through death of infested animals.

In Alberta there are nine major insect pests of cattle. These include: cattle grubs (warble flies), cattle lice, black flies, horn flies, mosquitoes, house flies, stable flies, face flies and horse flies. The warble fly has the potential for causing major losses in the cattle industry. In 1968 a survey showed 45 per cent of cattle slaughtered in Alberta packing plants in the period March through May were infested with warbles. It is estimated that the losses to the packing industry alone exceeded four million (1988) dollars. Losses at the producer level would have added to another four million dollars. In 1975 the warble fly was declared a pest under the Agricultural Pests Act, and livestock producers are required to take measures to control the pest in their herds. By 1988, packing plant inspections showed fewer than 1 per cent of carcasses were infested. A second pest of major economic importance in the north east region of the province is the black fly. Annual losses in excess of $500,000 have been reported as recently as 1978. In one year 135 animals were killed, and there were additional losses because of reduced gains and breeding performance due to the black fly attacks.

The objective of this section is to provide information to beef producers on:

- recognition of insect pest problems
- basic biological features of insects important in prevention and control
- pesticide recommendations for proper pest management.

Cattle grubs

Biology

Cattle are the only hosts of two species of cattle grubs, the common cattle grub and the northern cattle grub. They are generally referred to as "warble flies", "bomb flies" or "heel flies".

The life cycles of the two species are similar. The grubs, which appear in the backs of cattle in the spring, are familiar to almost everyone who handles cattle. The grub-like larvae drop to the ground, pupate in the soil litter and adult flies, which resemble bees, emerge. These flies do not sting or feed. They simply mate and lay eggs on the hairs of the lower parts of cattle. The eggs hatch and the tiny larvae immediately burrow into the skin of the animal.

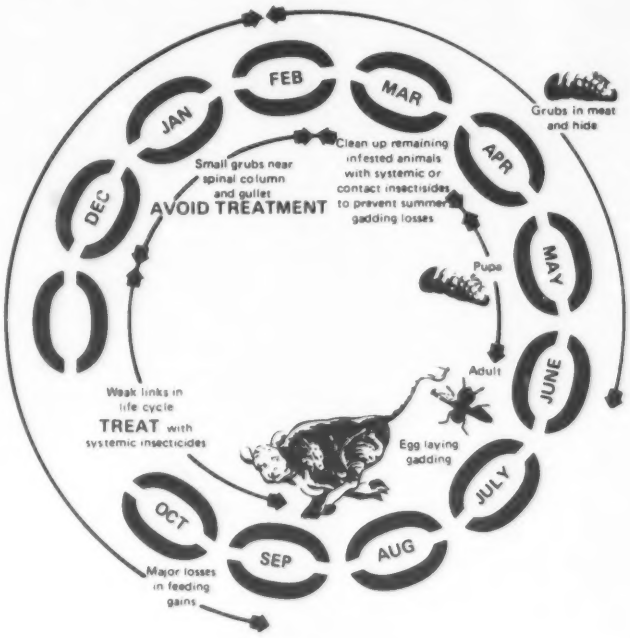


Figure 27 - Life cycle of the warble fly

The larvae migrate for several months through the animal body. The grubs reach the esophagus in the case of common cattle grubs, or the spinal canal in the case of northern grubs. The grubs stay at these locations several weeks, then migrate to the back directly beneath the hide. They form breathing holes to the outside at this stage and they are called "warbles". After the larvae are fully grown in the warble cysts, they drop to the ground during the spring and begin their new annual life cycle (Figure 27).

Type of injury and economic loss

Except for the pupa, every stage in the life cycle of the warble fly does some damage to the host animal. The northern species of the warble fly, during egg laying, attacks and terrifies cattle. The cattle react and run with tails in the air to avoid the flies. This is referred to as "gadding". Gadding causes physical injury to animals when they run through fences and into other objects. It also results in reduced gains and milk production. The weaning weights of calves may be reduced by 20 kg (44 lb).

If overwintering larvae in steers are controlled, the animals may gain 0.1 kg (0.2 lb) per day more

over a 180 day period or an extra 18 kg (40 lb) per steer.

Warble grubs in slaughter cattle cause considerable damage to carcasses and hides. As a result, carcasses are discounted and downgraded. Time involved in trimming damaged carcasses is one of the indirect losses to the livestock industry.

Control

Cattle grubs can be effectively controlled by applying systemic insecticides in the fall to beef cattle and non-lactating dairy animals. Systemic insecticides are Co-ral, Ruelene, Neguvon, Grubex, Spotton and others. A treatment applied immediately after the first killing frost, is more effective than a late treatment in November. These compounds are available in spray, pour-on and spotton formulations.

Cattle Lice

Biology

Two types of lice are commonly found in Alberta, biting or chewing lice and sucking lice. Biting lice feed on outer layers of skin, scurf and dead tissue while sucking lice feed on blood by piercing the skin.

Cattle lice are specific to cattle and spread from one animal to the next by contact. They are permanently parasitic and spend their entire life cycle on the host. The egg, nymph and adult can all be found on the host animal. Female lice glue their eggs to the hair of animals. They hatch in one or two weeks. The newly hatched nymphs resemble the adult lice except that they are smaller. The nymphs mature into adults in two or three weeks time; the adult can lay one or two eggs per day for about two weeks. The entire life cycle can be completed in a month's time. Lice occur on cattle all year round but infestation becomes noticeable and severe during winter and spring months.

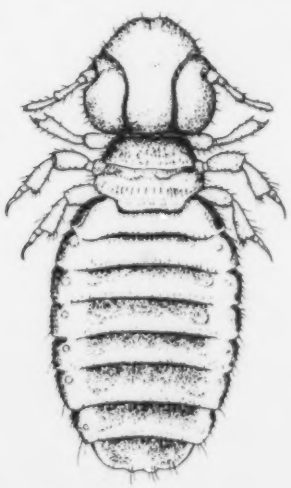


Figure 28 - Cattle louse

Type of injury and economic losses

Cattle infested with lice are easy to recognize. Bluish colored patches may appear on the head, neck and shoulders. In severe cases the hair becomes rough, dirty, greasy and polluted with blood from crushed lice. The feeding activity of the lice irritates the skin and the animals rub themselves trying to relieve the itching. The constant rubbing of cattle irritated with biting lice results in open sores which may provide entrance for infectious agents. The irritation makes the animal nervous, edgy, go off feed and fail to gain at a normal rate.

Blood sucking lice can reduce, by up to one third, the total number of red blood cells in the animal's body. Insufficient red blood cells may result in anemia, marked by paleness of the eyes. Anemic cattle become weak and susceptible to respiratory diseases. Pregnant cattle may abort and, with the added stress of cold, sudden death may occur.

It is estimated that in North America the annual loss caused by cattle lice is over $6 million. Because animals infested with lice are less attractive, the market value of commercial and purebred stock is reduced. Indirect losses such as reduced weaning weight and reduced breeding ability of the bull are also reported to occur in herds where lice are not controlled.

Studies have shown that cattle treated for lice may gain an additional 0.05 to 0.54 kg (0.1 to 1.2 lb) per day, depending on how severe the infestation has been.

Control

To prevent the build-up of a heavy infestation in a herd, producers should check their animals early in the fall for signs of lice. It is particularly important to spot a carrier animal which becomes habitually lousy each year. These animals are a source of infestation to the entire herd and should be eliminated as soon as possible.

A preventive treatment early in the fall with an insecticide effectively controls the population of lice that occurs at this time. This is usually done at the same time as cattle are treated with a systemic insecticide for the control of cattle grubs.

A second treatment before the onset of cold weather ensures protection from a severe infestation.

Self-treatment devices such as dust bags, oilers and backrubbers eliminate the work of applying insecticide. Concentrated pour-on, spotton and dust can be applied to individual animals. For complete recommendations and a detailed life cycle of lice, refer to the Alberta Agriculture publication *Control of Cattle Lice* (Agdex 420/651-2).

Black flies

Biology

Black flies are among the smallest of the biting flies that attack cattle. They are generally referred

to as "buffalo gnats" because of their humped back. They are also commonly known as "sand flies".

There are four stages in the life cycle of the fly. Egg, larva and pupa are found in running water, whereas adult flies feed on animal blood and plant juices. The eggs are laid by the female black fly on or in the water. The larvae remain attached to substrates such as rocks and submerged vegetation. They obtain food through a method called "filter feeding". The larva is transformed into a pupa and remains attached to the substrate until it emerges as an adult fly.

The female black flies, when searching for their hosts, move in swarms to attack cattle and other livestock. The duration of each stage and the number of generations during the summer months varies with the species.

Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 29 - The black fly. The adult of this species is approximately 3.5 mm long

Type of injury and economic losses

Black flies are attracted to host animals in swarms; and as they fly about, they often get into the nostrils and mouth. If they are inhaled, they form a ball of mucous-coated flies, which may mechanically choke or suffocate the animal. They feed either on exposed areas of skin around the eyes, ears, nose and mouth, or they crawl into the hair coat. The bites cause severe itching, swelling and irritation that lasts for several days. Cattle deaths result from suffocation and anaphylactic shock. Significant losses because of reduced weight gain and reduced milk production have been reported during black fly activity. The weaning weights of calves can be affected because of damaged udders. Numerous bites on the scrotum and sheath of bulls reduce their breeding ability.

Control

Backrubbers charged with insecticide repellent mixtures provide protection from black flies. Installing these self-administered devices at the entrance of dark or semi-dark shelters has proven very effective. During severe black fly attacks, cattle seek shelter in bush or in semi-dark buildings when they are available.

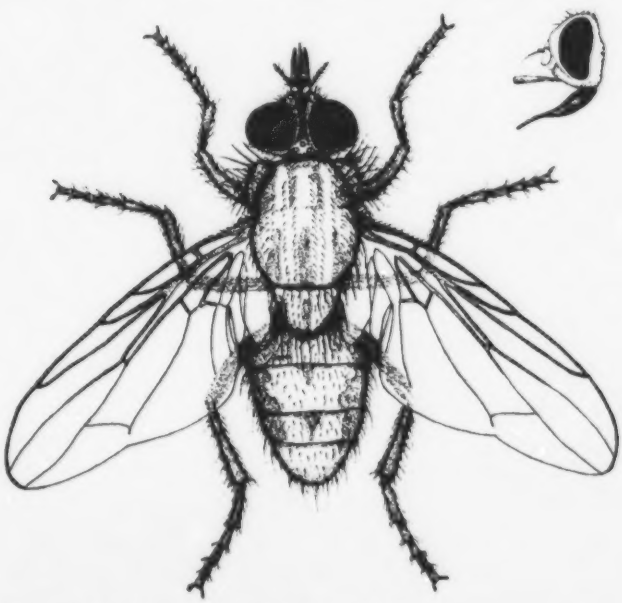
Larviciding rivers and creeks for controlling black flies should never be undertaken by laymen, but should be entirely the responsibility of professional people and abatement authorities.

Horn fly

Biology

Horn flies are small dark grey flies about one-half the size of a horse or stable fly. They are easily recognized as they rest on animals with their heads facing downwards. They congregate in clusters and always prefer the side of the animal that is in the shade. Unlike other biting flies, they survive on the host animal. After persistently feeding day and night they leave the host animal only long enough to lay eggs in freshly dropped manure.

The female flies lay reddish-brown eggs in the manure and immediately return to the cattle. When the larvae hatch from the eggs and complete their development, they migrate down to the soil and are transformed into barrel-shaped dark pupae. Within a few days, adult flies emerge; succeeding generations follow each other through the season. Horn flies overwinter as larvae and pupae.



Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 30 - The horn fly. The adult is approximately 4 mm long.

Type of injuries and economic losses

Horn flies are the worst biting species affecting cattle. Their numbers peak in July and August in most parts of Alberta. In heavily infested herds, as many as 3000 to 4000 flies can be found on bulls, while cows and steers will carry 300 to 400 flies per head.

Both male and female flies have beaks which they use to obtain blood meals. Studies conducted at the Lethbridge Research Station indicate that 40 or more flies per animal warrant immediate control measures because they lower the performance and productivity of the animal.

It is estimated that 288,000 flies would consume over one litre of blood per day. The annual losses from horn flies in Canada have been estimated to be in the millions of dollars.

Control

Several insecticides and methods of application are available for combatting these flies. Horn flies are one of the easiest pests to control because they remain on the animal day and night. Providing access to self-treatment devices such as backrubbers and dust bags is effective. Installing them near a water source and salt licks that cattle visit once or twice during the day is most effective.

Spraying and hand dusting at frequent intervals is labor intensive but provides excellent control. Insecticide eartags are the simplest and most effective method of applying insecticide for the control of horn flies.

For further details please refer to Alberta Agriculture publication *Control of Horn Flies* (Agdex 420/651-3).

Mosquitoes

Biology

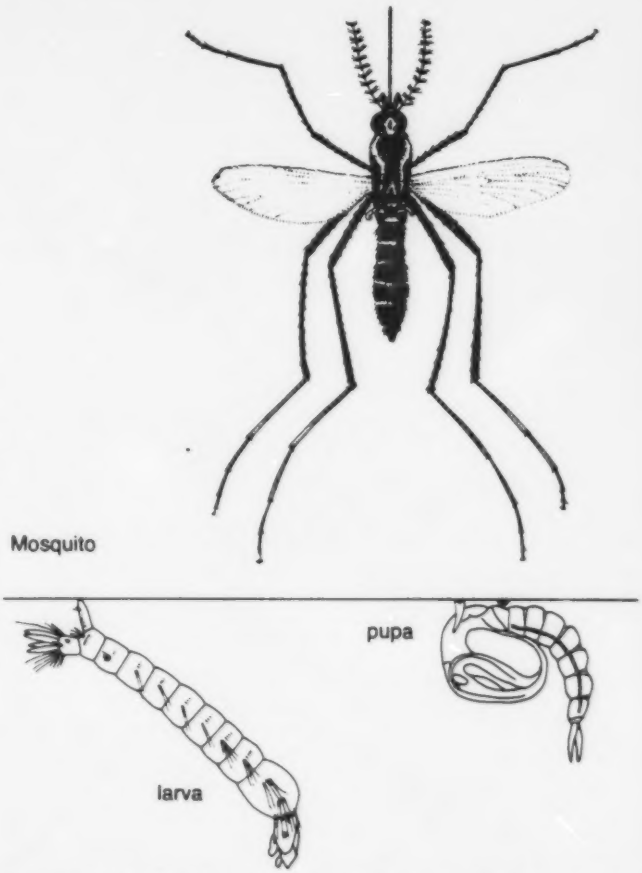
There are about 35 different species of mosquito in Alberta. Mosquitoes require water to complete their life cycle. The four stages of the life cycle are egg, larva, pupa and adult. The eggs are laid on or near water. When there is contact with water the eggs hatch and produce larvae or "wrigglers". These can be found in standing water in pastures and along roadside ditches. The larva is transformed into a "comma" shaped pupa called a "tumbler", which swims to shore, and in a few days an adult mosquito emerges from the pupa.

Female mosquitoes are blood feeders while males feed on plant juices. In most of the species there is only one generation per season. All eggs do not hatch at one time. Successive flooding of the pools may produce several broods during the season. Some species of mosquito overwinter as adults and others in the egg stage.

Type of injury and economic importance

Female mosquitoes require a blood meal before egg laying. Of all the species, Aedes or flood-water mosquitoes, are the most serious pest of cattle. Breeding habitats for this species in Alberta are vast and numerous. Severe attacks on cattle occur in the early morning and evening hours. During mosquito attacks cattle exhibit behavior changes such as stampeding, bunching together on higher ground and licking each other to get relief from the bites.

Losses by mosquito-worrying of cattle are considerable. In affected areas a drop in milk is noted in dairy cattle.



Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 31 - The mosquito

Loss of blood results in poor weight gains and loss of condition. In extreme cases the death of small calves has been attributed to worry and loss of blood.

Control

All mosquitoes require water for the immature stages to develop. Eliminating the sources of breeding, such as rain filled ditches, ponds and shallow pools resulting from the melting of snow in the spring, will greatly reduce the mosquito population.

Protecting cattle from mosquito attacks is

possible through frequent application of fast-acting insecticides or insect repellent combinations. This can only be achieved if cattle can be handled frequently, or if they have access to self-treatment oilers.

Organizing an area control program through municipalities is another way of reducing losses caused by mosquitoes.

House fly

Biology

A common pest well-known to everyone is the house fly. The house fly's annoying habits and the fact that they are a potential vector of many diseases make them a public health concern. The house fly is closely associated with human activity and can use a variety of forms of organic matter for breeding and feeding purposes. Livestock buildings and feedlots in particular have an abundance of organic waste suitable for house fly multiplication.

The house fly has four stages in its life cycle: egg, larva, pupa and adult. Eggs are laid in manure, rotting bedding or silage pits where the larvae hatch and pupate. The entire life cycle is completed in two weeks. House flies overwinter as adults in farm buildings.

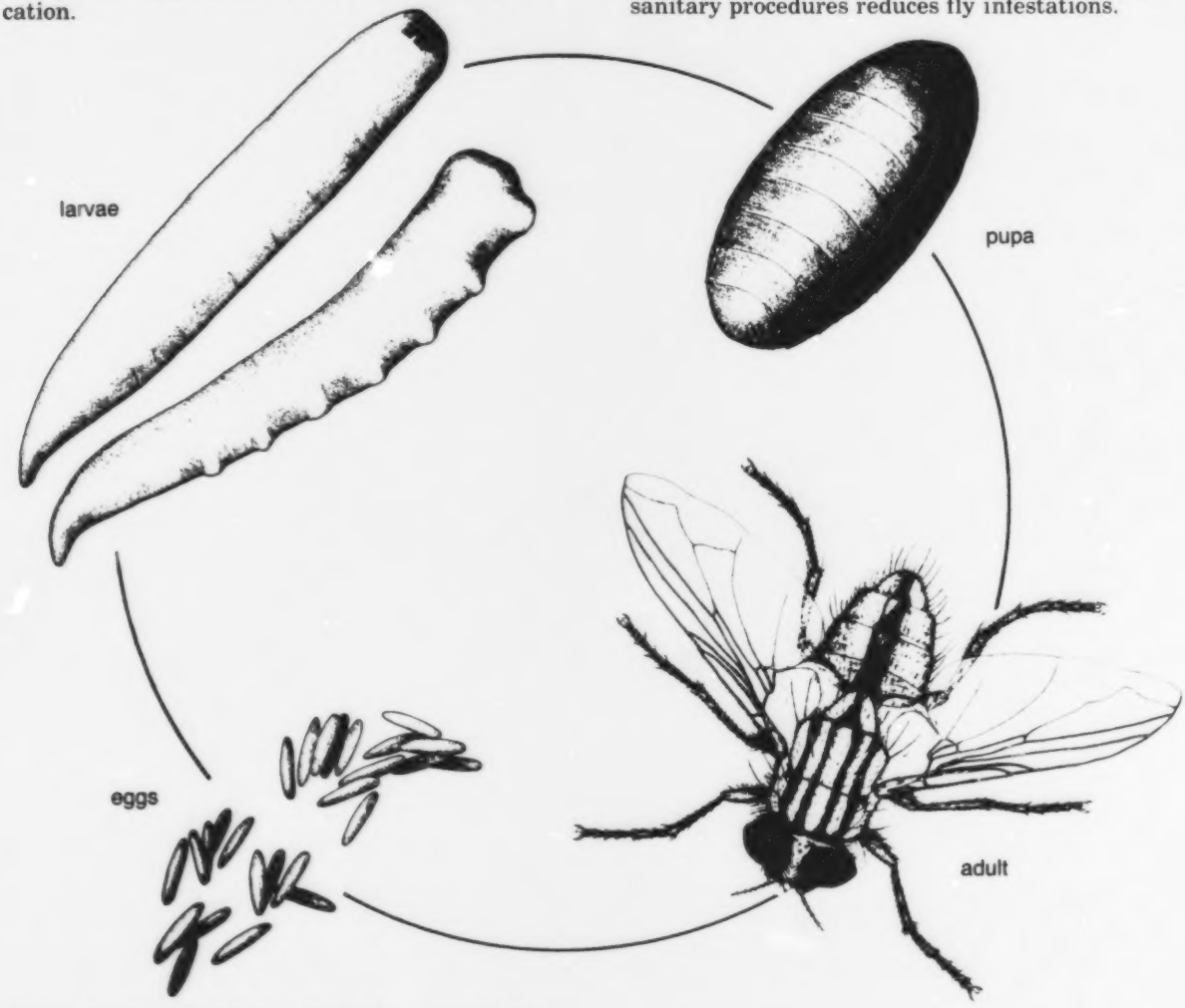
Type of injury and economic importance

The role of the house fly as a carrier of livestock diseases has not been extensively studied. It is suspected that many diseases of animals are transmitted by flies because they have ready access to the feces and wounds of infected animals.

House flies worry livestock with their persistent attention and are responsible for loss of condition. Cattle often suffer with inflammation of the eyes during fly time. This condition can be spread through a herd from one animal to another by flies.

Control

Eliminating the breeding sources through proper sanitary procedures reduces fly infestations.



Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 32 - Stages in life cycle of house fly.

Residual wall sprays containing insecticides, fly papers and poisoned baits are some of the methods of control.

A weekly schedule for disposing and spreading cattle manure is the key to good house fly control.

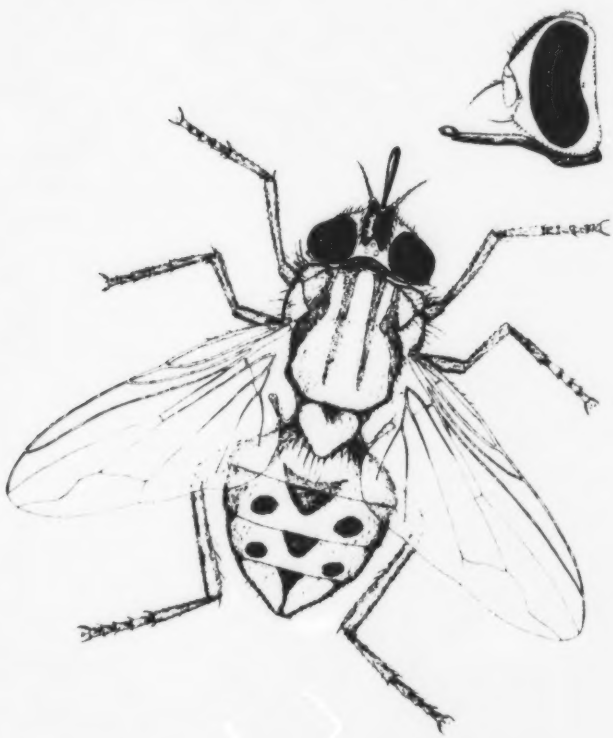
Stable fly

Biology

The stable fly resembles the house fly except for a pointed beak held straight out in front of the face. They are also referred to as "biting house flies" or "dog flies". They rest on the sunny sides of the walls of the stable and other farm buildings with the face pointing upwards away from the ground.

Stable flies are not host specific and will attack cattle, pigs, horses, dogs and even man.

The life history and early stages of a stable fly are very similar to those of the house fly. The entire life cycle is completed rapidly in 24 days. Stable flies can produce several generations per season. Wet feed or hay contaminated with manure, urine and mud are particularly good media for development of the stable fly. Decaying weeds along the lake shore or rotten lawn clippings are sometimes the breeding grounds for these flies.



Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 33. The stable fly. The adult is about 6 mm long.

Type of injury and economic importance

Both male and female stable flies bite cattle principally on the legs. When flies are numerous in a barn the cattle get no rest from daylight until dark and continually stamp their feet and twitch their bodies. The bites are very painful because they pierce the skin with their beak and suck blood.

Research has shown that stable flies affect the weight gains of feeder cattle and reduce milk production in dairy cattle.

Control

Eliminating sources of stable fly breeding is the least expensive and most effective method of control, yet it is generally ignored.

Accumulations of larval-sustaining media such as manure, old hay and straw stacks in feedlots and around farm buildings are frequently found responsible for a stable fly outbreak.

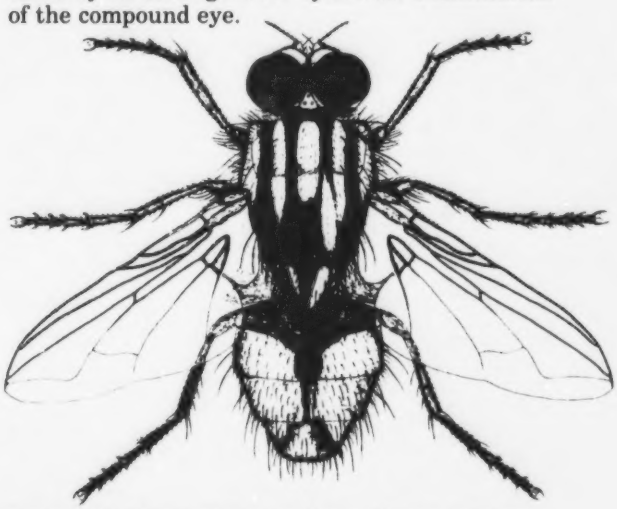
Spraying the resting areas of flies outside of farm buildings also helps to control stable flies.

A light spray of 0.9 per cent dischlorvos solution at the rate of 30 to 60 ml per head on the legs and lower part of the body is required daily to keep stable flies off cattle.

Face fly

Biology

The face fly is an important non-biting fly affecting cattle. This insect resembles a house fly and can only be distinguished by a close examination of the compound eye.



Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 34 - The face fly. The adult is about 8 mm long.

The life cycle of face flies is similar to that of house flies except that the pupae of the face fly are white whereas the house fly pupae are brown.

Eggs, larvae and pupae can be found in cattle droppings in the pasture. Because of a short life cycle, many face fly generations can be produced in one season. Face flies are strong fliers and can travel several kilometres. They overwinter as adults in animal shelters.

Type of injury and economic importance

Face flies have an annoying habit of landing on the face and probing eyes and nostrils. They feed on the mucous secretions and tears produced by persistent probing of the eyes.

In areas where face flies are abundant, pinkeye and a condition caused by physical abrasion of the eye have been reported. Face flies may play a role in disease transmission. Fifty or more flies are considered abundant and can cause economic loss through loss of condition of the cattle.

Control

Face flies do not enter darkened barns and stables. Show animals can be protected by keeping them indoors. Self-treatment devices such as oilers are equipped with face fly mops. Dust bags installed in the loafing areas may provide effective control. Insecticide-impregnated eartags are effective for controlling face flies.

Horse fly

Biology

There are many species of horse flies that attack cattle and feed on blood.

Adult horse flies are large and sometimes referred to as "bull-dogs". Eggs are laid on stems and leaves of aquatic plants. Larvae are carnivorous and feed on mosquito larvae and other aquatic insects. There is one generation of horse flies per year. The larvae migrate to damp soil. They pupate in decaying organic matter near the shore of a pond. The pupae hibernate and emerge the subsequent season.

Type of injury and economic importance

Adult horse flies emerge from the overwintering pupae in late June and early July. The female flies attack cattle and horses and their bite, which is extremely painful, causes considerable bleeding. Often a large number of flies are attracted to the blood pool. A peculiar habit of the flies is that they bite several times before they feed; this causes considerable worry to cattle resting in the shade.

Control

It is very difficult to control these flies at the breeding sites. Cattle can be protected by applying chemical repellants frequently during the summer or keeping the animals indoors when flies are active on hot summer days, but unfortunately neither of these methods is practical for most beef herds.

Courtesy: R.V. Peterson, Diptera Unit, National Museum, Washington, D.C.

Figure 35 - Horse fly. The adult is about 20 to 25 mm long.

Livestock insecticides

Insecticides selected for use on livestock for the control of arthropod pests are specialized chemicals with low vertebrate toxicity and very high toxicity to insects and related groups of animals. They are classified as either contact or systemic insecticides.

Systemic insecticides

Regardless of their method of administration to the host, these compounds are absorbed to the blood system of the host and then ingested by the parasites living in or on the host's body. Organophosphorus compounds, such as coumaphos, crufomate, fenthion, phosmet and trichlorfon, are systemic insecticides, which are applied to the skin for controlling cattle grubs lodged inside the animal's body or in the warble.

Contact insecticides

These compounds are toxic only when brought in direct contact with the parasite and are applied

directly to the parasites living on the hosts' body or in the warbles. Rotenone and malathion are examples of contact insecticides.

Insecticide formulations

There are several different kinds of insecticide formulations available. Some are ready-to-use directly from the container, while others require diluting and mixing before application.

Wettable powder or WP

This is a formulation in which the active ingredient is absorbed on a carrier material that is wettable in water. The formulation, when mixed with water, forms a suspension rather than a solution. Unless constantly agitated, the material will settle out. Pumps that are not thoroughly flushed out with water after use of wettable powders may be damaged or clogged. Follow label instructions in mixing and using wettable powders so that difficulties in spraying and possible damage to equipment may be avoided.

Dusts

They are usually specially prepared formulations for *dry application* in which the active ingredient is diluted to a low concentration with an inert dust for direct application. Wettable powder formulations should not be used as dusts. The rate of absorption of the active ingredient by the skin is usually greater for a wettable powder than for a dust preparation with equal concentrations of active ingredient.

Emulsion, emulsible concentrate or EC

An emulsion is a liquid concentrate containing emulsifiers to keep the active ingredient in uniform concentration in a tank and requires less stirring of the mixture.

Methods of insecticide application

This is to familiarize the user with commonly used insecticide application techniques and terminology. More specific information is usually provided with the insecticide container. *Reading and following the instructions on the insecticide label is very important for protection of both the human and animal.*

Livestock spray

Diluted liquid insecticides are applied by means of high-pressure spray. The pressure should be about 2400 kPa (350 psi). This is important because wetting the skin is necessary for thorough coverage of the cattle; 7 to 14 L of spray per cow or 5 to 7 L per calf may be required.

Mist spray

A hand operated electric spray (mister) is used for applying small quantities of concentrated insecticides. Mist applicators can also be used as space sprays. They deliver a coarse spray to cover the hair coat of the animal.

Residual wall spray

Very low pressure i.e., 550 kPa (80 psi) is required to apply insecticide to walls, ceilings, fences etc, to the point of run-off. This can be used for controlling house flies and stable flies that rest on the walls. Usually, animals should be removed from buildings before spraying; avoid spraying feed and water.

Back rubber

An inexpensive and effective device for applying insecticides is the back rubber. There are different commercial types available. These can also be manufactured by farmers themselves. A simple form consists of 5 to 6 m (15 to 20 foot) length of cable, chain or wire around which several layers of burlap are wrapped. By regularly resoaking the back rubber with a selected insecticide-oil mixture, they can be used year-round for controlling various pests.

Pour-On

This quick and simple method of application was developed for the systemic insecticides and can be used in controlling cattle grubs. The pour-ons are usually concentrated solutions of either oil or water emulsions poured along the back line of the animal with a small dipper at the rate of 15-30 ml per 50 kg (100 -lb) body weight. Pour-on formulations are useful for the treatment of cattle for lice in the winter months.

Spot treatment

This is very highly concentrated solution of insecticide. There are special applicators for applying these insecticides to cattle. Small dosages, ranging from 4 ml to 20 ml depending on body weight, are applied as spot treatment. Cattle grubs and cattle lice can be effectively controlled by this method.

Dust

A small number of animals may be individually hand dusted with insecticides. Dusts can be applied using a shaker can and working the dust into the hair coat. Dusts are effective against lice and horn flies.

Dust bags

Dust bags are self-treatment devices consisting of heavy duty burlap bags with a waterproof coat. They are hung in doorways or installed at the entrance to the watering facilities or mineral salt licks. When the animal bumps or rubs against the

bag small quantities of dust sift through the bag.

Dust bags can be manufactured on the farm by purchasing insecticide and heavy burlap sacks. This is an inexpensive way of treating cattle for lice, horn flies and other insects.

Insecticide eartags

Insecticide impregnated eartags are a simple method for applying insecticides to cattle. The slow release formulations of insecticide spread on the hair coat and other parts of the body when animals groom themselves. Horn flies and face flies are effectively controlled by this method.

Table 44
Insecticide Recommendations for Beef Cattle and Around Farm Building—1988

Pest	Insecticides
Face Flies	1) Croloxyphos (Ciodrin), 2) Ciovap
Horn Flies	1) Crotoxyphos (Ciodrin), 2) Ciovap 3) Lindane, 4) Malathion, 5) Methoxychlor, 6) Ronnel (korlan)
House Flies	1) Baytex, 2) Diazinon, 3) Dimethoate, 4) Malathion, 5) Ronnel, 6) Ravap
Lice	1) Carbaryl (Sevin), 2) Crotoxyphos (Ciodrin), 3) Crufomate (Ruelene), 4) Fenthion (Tiguvon), 5) Fenthion (Spotton), 6) Lindane, 7) Malathion, 8) Ronnel (Korlan), 9) Rotenone, 10) Trichlorfon, 11) Ivomec
Stable Flies	1) Crotoxyphos (Ciodrin, 2) Ciovap
Warble Grubs	1) Coumophos, 2) Crufomate (Ruelene), 3) Fenthion (Tiguvon) 4) Fenthion (Spotton), 5) Rotenone, 6) Trichlorfon (Neguvon) 7) Ivomec, 8) Warbex, 9) Phosmet

Handling and Housing Facilities

The design of beef cattle facilities is largely a matter of providing the required space, shelter, feed, water, waste management and livestock handling features. The facilities must then be adapted to the natural features of the site and organized for efficient and easy operation.

Handling facilities

Cattle handling facilities are an essential part of any cattle operation. Well constructed and functional handling facilities contribute much to the easy, safe and rapid handling of cattle.

The handling corrals should be accessible to all pens and located in an area where there will be all-weather access. The main parts of the corral handling system are:

- holding and crowding pens
- working chute
- squeeze chute
- loading chute
- scale.

New generation corral systems

Many of the beef cattle in Alberta are raised on mixed grain - livestock operations and not in the traditional ranching situations with skilled ropers and cow-horses. Therefore, effective management of the beef herd requires an efficient set of corrals and working systems so that cattle can be be treated when necessary with the least possible stress to both the animals and the owners.

Until recently, most working corral systems have been of the traditional "square box" design. In the past ten years, however, a better understanding of how livestock react to various handling situations has led to a new generation of corral systems.

These systems allow the operator to work with the livestock and their behavior rather than in conflict with them.

General principles

The "flight or fight" reaction is a common response in all animals when they are threatened, including cattle. Cattle will tend to move away from the people working with them. If pressed too close, they will turn and charge or try to escape by running past or over the handler.

Because cattle cannot easily see directly behind themselves, they will circle so that they can keep a person, horse or working dog in view.

Cattle are easily frightened or "spooked" by visual patterns of sharply contrasting bright and dark areas. For this reason, they will resist going from a brightly lit area into a darkened doorway. They will also balk when they see a shadow pattern of bars that appears to block their way as they go down an alley way or working chute.

With this knowledge in mind, the new generation of working corrals are designed with a minimum of corners that would cause cattle to feel trapped and to try to escape past the handler. Fence lines and working chutes are curved to allow the cattle to circle as they move away from the handlers. Working chutes and alleys near the working chutes are made with solid walls to eliminate the shadow patterns that can cause the livestock to balk. Solid walls also help to reduce the chance of injury from legs being caught in the spaces between the planking of the working chutes.

The modern systems are designed to allow the cattle to think that they are escaping as they move away from the handler (from the holding area, through the working alley, the crowding gate and the working chute) to the squeeze where the processing is to be done.

It is important to remember that the working corrals should be reserved for handling cattle. Cattle should be fed in a separate area that has easy access to the working corral system.

Components of the system

Holding corral

The access to the holding corral requires careful planning. The gateway has to be a trap that the cattle will easily move into. A "wing" provided by corral type fencing may be used to lead the cattle to the corral itself. The closer the cattle get to the "trap", the stronger must be the fence. The shape of the holding corral must be designed to allow the fleeing cattle to imagine they are escaping. It should have a curved perimeter fence and a funnel from the holding corral to the crowding gate leading to the working chute. The outer fence of the holding corral should be solid to avoid any of the distracting shadow patterns that could cause cattle to shy away from it.

Crowding gate and pen

The crowding gate must be heavy, easy to push and solid so that the cattle cannot see the handler and a possible escape route behind him. The only obvious escape should be through the exit to the working chute.

The crowding gate is usually 12 feet long, and swings in an arc from 180 to 300 degrees behind the cattle. The crowding pen is sometimes called a "tub". It is the final point in the whole trap. Once the crowding gate swings behind the cattle, they are caught for good. The crowding gate should have a ratchet latch which prevents the cattle from pushing it back against the operator.

Working chute

The working chute lines up the cattle in single file and sends them to the squeeze, or the scale. It should be tightly planked and 28 inches wide inside. To accommodate a very large bull, the chute should be expanded to a 30 inch inside width. Many working chutes are tapered from a width of 32 inches, at 30 inches above the ground, to a width of 18 inches at the ground, this will accommodate the largest herd bull, but still prevent calves from turning around in the chute.

The chute should be built on a curve that corresponds to the outside of a circle with a radius of 25 feet. To prevent the cattle from backing up, 1/2 inch chains may be strung across the chute every 6 to 8 feet, fully adjustable for different heights to accommodate mature stock or weaned calves. The chains should sag about 10 inches. Cattle can move freely under the chains but cannot back up when a chain drops behind the animal.

Loading chute

The loading chute should be located at an angle to the working chute, directly past the crowding gate. The gate and fence between the two chutes becomes a baffle gate, which deflects the cattle either way. The loading ramp should be bent in a "dog leg" so that cattle don't see a straight ramp leading into the truck. Two 15 degree bends, one at the bottom and one in the middle of the ramp will do well. The ramp should be about 54 inches wide and 16 feet long. A A flat landing stage at the top gives good footing for unloading cattle.

Squeeze chute and vet gate

The squeeze chute can be purchased or made on site from wood. Whatever the model, it should provide humane constraint without choking the animal, whatever size. The working chute should be designed with a 2-foot access gate for veterinary work immediately behind the rear entry to the squeeze.

Scale

Most cow-calf operations do not need a large scale to handle cattle in groups. A small single animal scale can be placed in a bypass area on the outer circumference of the working chute so

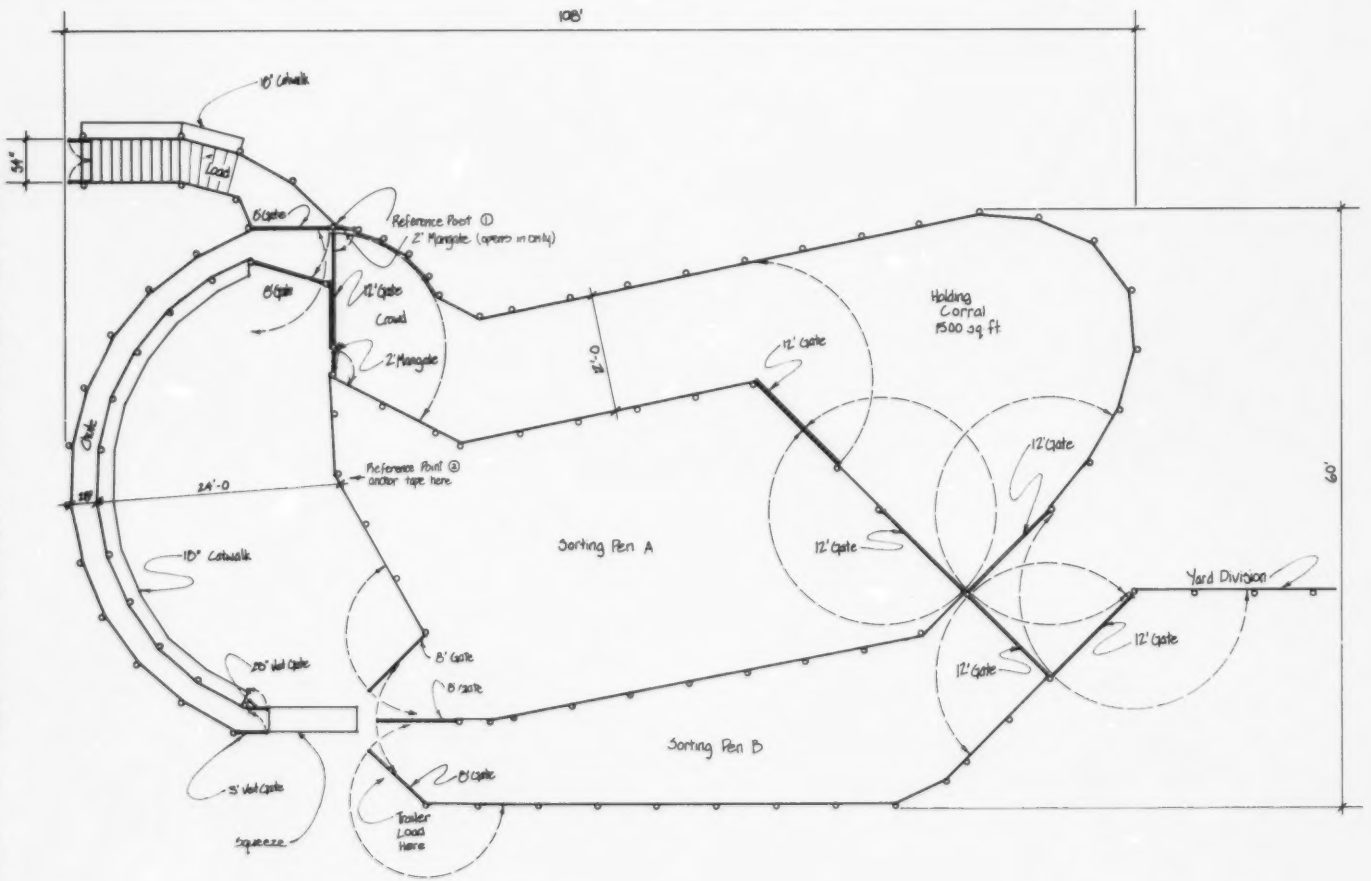


Figure 36 - 100 head cow-calf handling corral (brand on left side)

Notes

- Solid fencing along both sides of holding corral and all chutes 12" space at bottom, 10 planks to 6' height
- Use 2"×6"×12' planks throughout except for 2"×6"×14' "ties" across the top of 6, 12' gates
- Other fences, 5 planks, 6' to top, 12" from ground to bottom plank, 7.5" spaces between planks.
- Sorting Pen A is approximately twice the area of Sorting Pen B
- Gates: 7 - 12' Gates
  4 - 8' Gates
  2 - 2' Man Gates
  1 - 20' Vet Gate
  1 - 5' Vet Gate
- Posts: 9' × 6" treated posts @ 6'-0 o.c. through out except -
  6 - 12' gates require 12'×8" posts
  3 - 8' gates @ squeeze require 10'×6" treated posts
  All posts - 5' in the ground.

Layout
Scale 1/8" = 1'-0

Title: 100 Cow-Calf Handling Corral (Registered Brand on Left Side)			
Designed: TJ	Date: 3/87		Plan
Drawn: LG	A Detail no.		
Checked:	BC Sheet no.		
Scale: 1/8" = 1'-0	Sheet of Origin		Sheet 1 of

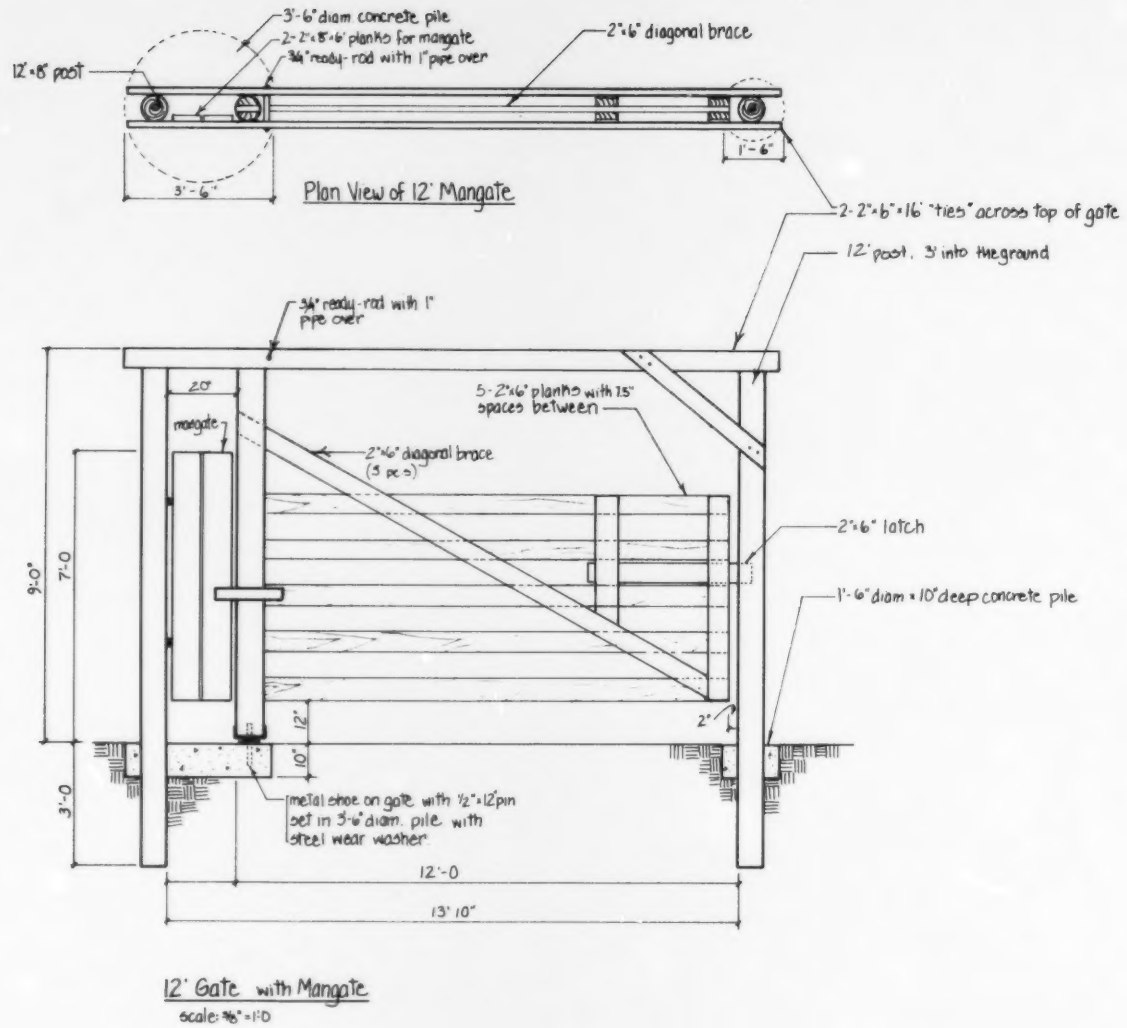


Figure 37 - Twelve foot gate with mangate

that it will not be necessary to cross the scale unless the cattle are to be weighed. In some systems, a portable scale is placed just in front of the squeeze chute if cattle are to be weighed.

Sorting corrals

Sorting corrals should have the same capacity as the holding pen. For most cow calf operations, three sorting corrals are adequate. They all must have access so that cattle can be routed either back into the holding corral or to the crowding pen for reworking. For many smaller farm cow-calf herds, it is convenient if the corral system will allow for one-man operation. This requires special attention to design of the sorting gates leading from the squeeze chute area into the sorting corrals.

Corral height

The corral should be high enough to hold the "jumpers" found in almost every herd. Fences should be at least 6 feet high. There should be 12 inches of free space at the bottom to allow people to roll under if an animal decides to fight. Rough planking is stronger than planed lumber. It is more economical to use 2 in. x 6 in. lumber than 2 in. x 8 in. material.

Gates

Gates are possibly the most important part of the handling system. They must be strong, quiet,

able to swing at least 300 degrees and must not sag or put strain on the fence itself. Fences should also be designed to lift easily over a build up of winter snow. Figure 37 shows a traditional design used by ranches in the interior of British Columbia for over 100 years, which meets all of these conditions. The gate can be constructed from planks, rails or steel as long as the hinging principle is observed.

Steps in laying out corrals

Materials

1. Gather materials: 50 ft or 100 ft measuring tape, 100 - 4 in. to 5 in. nails, 2 colors of surveyors flagging, 200 ft baler twine, carpenter's hammer.
2. Choose the most easily available building material. If lumber is to be used, rough is better than planed lumber, and 2 in. x 6 in. is more economical than 2 in. x 8 in. Before "staking" out the corral plan, you must determine the lengths available. Generally 16 ft lumber is best, and posts at stress spots will be 8 ft apart. If rails are to be used, fire kilned (peeled) rails are best, and they should be sorted for uniform length.

Location

3. The entire corral plan is determined by the registered brand location on the cattle. Once in the squeeze, *the brand side should be exposed to the inside of the curved chute.* Locate the position of the loading chute (figure 36), it must allow easy access for trucks. This determines the location of the rest of the corral system. Choose surveyors tape of 2 different colors, place 2 flagged nails of one color to mark the posts at the end of the loading chute, where the truck will touch. These should be either 38 in. or 64 in. apart, depending on the width of the chute.

Laying out the loading chute

4. With the steel tape anchored on one spike at a time, measure back 8 ft and flag, then 16 ft and flag with the color used at the end of the loading chute. Have a 15° bend, and be sure to keep the flagged spikes either 38 in. or 64 in. apart.

   One note about flagging, the nail, which is pierced through about 3 in. of flagging, is placed exactly where each post goes. The majority of posts will be 6 in. x 9 ft, to allow 2½ ft in the ground and 6½ ft on which to nail planks. The choice of a 38 in. wide loading chute with flags provides a finished inside dimension of 28 in., *which is the critical inside dimension for any chute.* The flagged width if 64 in. provides an inside finished dimension of 54 in. which is the other width you may choose for your loading chute.

   Keep the other color of surveyor's flagging for large gateposts. Note the shape of the loading chute on the attached plan. The bend occurs about one-third of the way "up" the chute.

Laying out the curved working chute

5. Next locate the two posts completing the entry to the loading chute on the outside. The post labelled (1) on the plan is the last of these. From this flag, measure 24 ft to reference point (2). Place a nail at this point through the end of the tape. You are now going to lay out the arc of the outside wall of the chute leading to the squeeze. First, however, place flagged nails at 19 ft and 9 ft from reference point(2), with the latter spike carrying your large gate post colored flagging. This is the post for the crowding pen gate (figure 37). The tape should be in a straight line from (1) and (2) directly over 2 different colored flagged nails.
6. Now start to move around the arc of the working chute. Place the first flagged nail at 8 ft, measuring from point (1). This is the gate post for the swing gate which directs cattle from either the loading or the squeeze chutes. Directly opposite this gate post (38 in.) is another gate post. This post should be 8 ft from the first flagged nail on the line between (1) and (2). You have now laid out the two 8 ft deflector gates.

   Using your carpenter's tape and the 100 ft steel tape anchored to the reference point at (2), start to flag the post points around the outside of the chute. Instead of using the carpenter's tape to measure the 8 ft outside flag points, you may use the knotted string described in No. 9 of these instructions. All the outside flagged nails are 8 ft apart. As each outside flag is placed, at the 24 ft mark, place another at the point on the steel tape measuring 20 ft 10 in. When finished with 6 in. posts and 2 in. rough lumber, *this will provide 28 in inside chute width, which is critical.*

Locating the squeeze

7. After the arc is completed, place the last 2 flagged nails for the posts that will anchor the squeeze. Arrange these posts to provide the small vet gate behind the squeeze.

8. Measure the length of your squeeze, and temporarily outline its position at the end of the chute. If possible, actually put the squeeze in. Place.

Locating the perimeter fence and gates

9. Decide on the location of the perimeter fence around the entire corral from the squeeze to the loading chute. Bring out your baler twine, and form loop knots every 8 ft. The loop should fit over a flagged nail, which marks a post, so be sure that the loops are exactly 8 ft apart and that you have at least 200 ft of twine with loops. This allows use of 16 ft lumber. (If lumber is 14 ft, knot every 7 ft; if 12 ft, knot every 6 ft) Anchor the first loop with a flagged nail exactly 10 ft out from the centre of the front of the squeeze. This is a post for a sorting gate. Now attach the other end to the flagged nail at (1) (figure 36). Lift up the string and lay it out in an oblong shape as shown in the plan. Wherever you want a gate, just omit one loop, and a 16 ft gate opening will be available. Put flagged nails through every other loop.
10. Care must be taken to complete the exterior fence of the crowing "tub", so that the 12 ft crowding gate will allow you to crowd groups of cattle into the chutes. The best way to do this is to first install the crowding gate, then mark the outside of the "tub" for the posts. Generally, the posts will be about 3 ft apart. Follow the plan when planking this part of the fence so that the gate latch will lock on the planking as cattle are crowded.

Laying out interior fences and gates

11. Now lay out and "flag" the interior corral fences. The alley leading into the tub should not be wider than 12 ft. Sorting corral divisions should be laid out *starting 10 ft away from the front of the squeeze.*
12. Finally, wind string around all your flagged nails, so that the detail shows up. Cut the string at all gates, and substitute with surveyors flagging. Walk through your corral and adjust it where necessary.

Calculating materials

13. Count the flagged nails to decide how many posts are needed. Add up all the 8 ft sections, divide by 2 and multiply by 6. This will tell you how many 2 in. x 6 in. x 16 ft planks in you will need. Multiply this figure by 16 board feet, and you will know how many board feet of lumber will be needed for 2 in. x 6 in. plank fences.

    Cattle are easier to handle if the fences are solid planked. This is particularly important at the "tub" and throughout both the loading chute and the chute leading to the squeeze.

Construction

14. When planking a fence, first nail on the bottom plank so that there is a uniform 12 in. space between the ground and the plank. Then by using a 6 in. spacer, all other planks can be nailed on. All posts should be pressure treated, and placed 30 in. in the ground, with at least 6 1/2 ft above ground, except in the chute leading to the squeeze, where 5 1/2 ft is enough. This means that most posts will be 9 ft long and the squeeze chute posts 8 ft long. Main gate posts (with gates 12 ft or longer) will be 12 ft long. The sorting gate posts positioned 10 ft from the front of the squeeze will need to be 8 ft long.

Gates

15. There will be 4 different kinds of gates.
    a) 12 ft gates or longer. Note that by just positioning these gates farther from the gate post, a "man-gate" can be made. (There are 7 large gates in the sample plan.)
    b) Two 8 ft gates at the beginning of the chutes are made of solid 2 in. x 6 in. planking. These are made simply by "stacking" the 8 ft planks and spiking them together with 8 in. spikes. Angle iron is bolted to both ends, and 18 in. gate hinges are placed on one end. Back brace the chute fence behind the hinges with #9 wire.
    c) "Man-gates" are the height of the fence. You can place them wherever you want, but there should be one at the hinge of the crowding gate in the tub; one opposite the final crowding position in the crowding tub, and two for the vet at the rear of the squeeze.

Helpful Hints

1. Use wood preservative wherever wood touches wood.
2. Use small washers under the spikes on rough planks.
3. Use ring or spiral 5 in. spikes for fences. Use 4 in. ring nails for gates.
4. Choose a flat spot for construction of large gates. Plan the gate so that it exactly matches the fence height on either side. For example, if a corral fence is made 6½ ft high with six 2 in. x 6 in. planks and with the first plank 12 inc. from the ground, then the gate should be identical.
5. Drill holes in planks to take 5/16 in. chains in the chute as shown on the plan. Drill extra holes higher and lower so that the chains are adjustable.
6. Plan to have the corrals suit your herd. If you have 150 cows, then it is possible to

tidebuild a holding corral large enough to hold 150 cows and calves by allowing about 4000 sq ft (20 sq ft per cows and 7 sq ft per large calf). Calculate areas by roughly estimating circular size needed to contain the area you need. The area of a circle is found from the formula: Area = $7\pi r^2$ (where $7\pi = 3.143$ and r = radius). For example, the area in the main portion of the holding corral on this plan is approximately 2300 sq ft, and the 12 ft wide alley leading to the crowding tub is about 400 sq ft, or a total of 2700 sq ft. This will hold about 135 dry cows or 100 cows and calves.

It is important that at least 2 sorting corrals be incorporated into your plan as shown, and that one be two-thirds and the other one-third of the area of the holding corral. You can add another sorting corral by simply adding another gate at the squeeze.

Finally, do not forget that cattle should flow through the system, so do not have sharp corners or long straight alleys. Your layout will depend on your registered brand location.

Working corrals should be located where cattle normally like to travel. Never feed cattle in the corrals so that manure builds up.

Table 45
Recommended Dimensions for Beef Cattle Corrals and Handling Facilities

	Less than 270 kg	Less than 595 lb	270 - 540 kg	595 - 1,190 lb	Over 540 kg	Over 1,190 lb
Holding Area						
- Worked immediately	1.4 m^2	14 ft^2	1.7 m^2	17 ft^2	2.0 m^2	20 ft^2
- Held overnight	4.5 m^2	45 ft^2	5.0 m^2	50 ft^2	6.0 m^2	60 ft^2
Working Chute w/Vertical Sides						
- Width	450 mm	18 in.	550 mm	22 in.	700 mm	28 in.
- Desirable length (minimum)	7.2 m	24 ft	7.2 m	24 ft	7.2 m	24 ft
Working Chute w/Sloping Sides						
- Width at bottom	375 mm	15 in.	375 mm	15 in.	400 mm	16 in.
- Width at top	650 mm	26 in.	700 mm	28 in.	750 mm	30 in.
- Desirable length (minimum)	7.2 m	24 ft	7.2 m	24 ft	7.2 m	24 ft
Working Chute & Feedlot Line Fences						
- Recommended minimun height	1,200 mm	48 in.	1,350 mm	54 in.	1,500 mm	60 in.
- Depth of posts in ground	750 mm	30 in.	750 mm	30 in.	900 mm	36 in.
Corrals and Bull Pen Fences						
- Recommended height	1,500 mm	60 in.	1,500 mm	60 in.	1,800 mm	72 in.
- Depth of posts in ground	900 mm	36 in.	900 mm	36 in.	1,200 mm	48 in.
Loading Chute						
- Width	650 mm	26 in.	700 mm	28 in.	750-875 mm	30-35 in.
- Length (minimum)	3.6 m	12 ft	3.6 m	12 ft	3.6 m	12 ft
- Rise rise:run	1:4	1:4	1:4	1:4	1:4	1:4
Ramp height for:						
- gooseneck trailer	375 mm	15 in.	375 mm	15 in.	375 mm	15 in.
- pickup truck	700 mm	28 in.	700 mm	28 in.	700 mm	28 in.
- van-type truck	1,000 mm	40 in.	1,000 mm	40 in.	1,000 mm	40 in.
- tractor trailer	1,200 mm	48 in.	1,200 mm	48 in.	1,200 mm	48 in.
- double deck	2,500 mm	100 in.	2,500 mm	100 in.	2,500 mm	100 in.
Access or Collecting Alley						
- Width	3.6 m	12 ft	3.6 m	12 ft	3.6 m	12 ft

Note: Cow-calf operations should utilize dimensions for over 540 kg(1,190 lb)

Table 46
Guidelines for Housing Beef Cattle (CPS plan 1000)

Requirements	Cows & Bred Heifers		Yearlings		Calves	
					225 kg	500 lb
Feedlot (without shed):						
– Hard surface[1]	8 m^2	80 ft^2	4.5 m^2	45 ft^2	4 m^2	40 ft^2
– Soil[2]	30 m^2	300 ft^2	25 m^2	250 ft^2	15 m^2	150 ft^2
– Bedded mound[3]	3.5 m^2	35 ft^2	3 m^2	30 ft^2	2.5 m^2	25 ft^2
Feedlot (with shed):						
Lot area[4]						
– Hard surfaced (min.)	5 m^2	50 ft^2	2.5 m^2	25 ft^2	2.5 m^2	25 ft
– Soil (min.)	30 m^2	300 ft^2	25 m^2	250 ft^2	15 m^2	150 ft^2
Shed area:						
– Floor area (min.)	3 m^2	30 ft^2	2 m^2	20 ft^2	1.5 m^2	15 ft^2
– Clear height (min.)	3 m	10 ft	3 m	10 ft	3 m	10 ft
– Slotted floors :						
- Space per animal	3 m^2	30 ft^2	2 m^2	20 ft^2	1.2 m^2	12 ft^2
– % of floor area slotted	100%	100%	100%	100%	100%	100%
Maternity pens:						
– Additional area (min) 1 pen/20 cows	3 x 3 m	10 x 10 ft				
Water[5]						
– Surface area per 25/head	0.1 m^2	1 ft^2	0.1 m^2	1 ft^2	0.1 m^2	1 ft^2
Feed bunk:						
– Length per head:						
- Simultaneous Limited feeding	650-750 mm	26-30 in.	550-650 mm	22-26 in.	450-550 mm	18-22 in.
– Full or self-feeding:						
- roughage	200 mm	8 in.	200 mm	8 in.	150 mm	6 in.
– complete ration	150 mm	6 in.	150 mm	6 in.	125 mm	5 in.
– grain	75 mm	3 in.	75 mm	3 in.	50 mm	2 in.
– Height at throat: (max.)	550 mm	22 in.	550 mm	22 in.	450 mm	18 in.
– Max reach (top of throat board to bottom outside corner)[6]	850 mm	34 in.	750 mm	30 in.	600 mm	24 in.
Feed Storage:						
– Hay, without silage amount/head-day (maintenance only)	11 kg	25 lb	7 kg	15 lb	5.4 kg	12 lb
- Silage, without hay	34 kg /head-day maintenance only	75 lb	2-2.3 kg day/45kg live wt.(fattening)	4.5-5 lb 100lb	16 kg /head-day	35 lb
– Grain & concentrate						
cows (head/day)	no grain	no grain				
fattening 2 yr olds	0.7 - 0.9 kg	1.5 - 2 lb				
yearlings[7]						
calves					0.7-0.9 kg	1.5-2 lb
Bedding storage (head-day)	2.3 kg	5 lb	1.8 kg	4 lb	1.4 kg	3 lb
Manure storage:						
– With bedding (day)	0.034 m^3	1.2 ft^3	0.023 m^3	0.8 ft^3	0.017 m^3	0.6 ft^3
– No bedding (day)	0.028 m^3	1.0 ft^3	0.021 m^3	0.75 ft^3	0.014 m^3	0.5 ft^3

[1]Slope: 2% to 4% on concrete.(Percent slope example: 4% = rise of 4 m for 100 m of horizontal distance).
[2]Slope: 4% to 8% on soil
[3]Slope mounds 1:4. Sawmill chips and shavings preferred to straw for bedding mounds.
[4]200 head is the maximum capacity of one pen.
[5]Water demand–average 45 L (10 gal)/head-day; peak (hot weather) 90 L (20 gal) /head-day.
[6]Bunk width: 1200 mm(48 in.) if fed from both sides; 1350-1500 mm (54-60 in.) if divided; 450 mm(18 in.) bottom width if fed from one side.
[7]In yearling rations grain may be substituted at the rate of 1 kg (lb.) for each 1.5 kg (1.5 lb) of hay.

Housing Facilities

Cattle suffer more from mud, harsh winds and excessive moisture than from low temperatures alone. Windbreaks and open front sheds will usually give adequate protection. For winter and early spring calving, a dry draft-free area is desirable. Planned housing and facilities can reduce labor, save time and feed and keep capital costs to a minimum.

Good tree groves make excellent windbreaks. Pens built 30 to 45 m (100 to 150 ft) downwind from the windbreak will allow room for snow to get trapped before it gets into the pens. Windbreak fences are a good alternative, (20% open and 80% solid) and a minimum of 2.5 m (8 ft) high.

To provide protection from wet snow, rain, wind and extreme temperatures, open front sheds are often used. They normally are naturally ventilated buildings and the most common ones are of a pole construction. A single sloped shed is the least expensive to build. The runoff from the roof goes to the back of the shed and sunlight reaches to the back of the shed. The open front clear span buildings can allow a deeper shed, which will reduce the amount of snow entering the building. It also allows for easier entry with a tractor and scraper for cleaning the shed. The open-end pole barn will help modify winter temperatures, but one can encounter moisture problems if relying strictly on natural ventilation.

Some intensive livestock operations have gone to total confinement barns for feeder cattle. They are insulated buildings with totally slotted floors over liquid manure pits. In this system, the space per animal is reduced to a minimum; the routine barn cleaning chores are virtually eliminated and the animals remain quite clean.

A cool dry calving barn is much more desirable than a warm humid one. A common practice is to make pens in the back of an open front shed. If these pens are kept well bedded and a heat lamp or infra-red lamp is used, the conditions will be quite comfortable. Avoid completely enclosed buildings unless they are fully insulated, ventilated and heated.

For complete construction plans for buildings and equipment and for more detailed information, contact your local district agriculturist, regional livestock supervisor or regional agricultural engineer.

Scale

A scale is essential for obtaining accurate performance records of cattle. Scales can either be fixed or portable, single or platform. A scale should not be placed in line with the working chute. This would mean that every time an animal is put through the chute it would pass over the scale and put extra traffic on the scale. Use a bypass between the working chute and the squeeze. The location of a platform scale is not as critical but it should be located so feed can be weighed as well as cattle.

Additional features

Hospital pens — A hospital or sick pen is a useful addition to any cattle lot and a necessity in larger ones. It eliminates the need to cut an animal from the main herd each time it is to be treated. This eliminates stress on both the ailing animal and the operator, especially where daily treatment is required for a period of time.

Sick pens should be located near the working facilities and should be sheltered and well bedded. Space requirement are not large--1.5 - 2.0m² (15 - 20 sq ft) for a shelter plus 4 - 6 m² (40 - 60 sq ft) of pen area per head based on 5 per cent of the herd.

Man-gate — (figure 37)--saves time when passing through a fence. Whatever the operator may be carrying does not have to be set down to open and close a gate. Cattle cannot pass through this type of gate.

Power outlet — This is almost a must somewhere near the squeeze. Electric clippers, dehorners, branding irons and even an electric heater for warming equipment or tools during cold weather are commonly used here. A yard light in the same general area will light up the whole working area.

Beef cattle fencing

Pasture fencing for a beef operation is used to contain cattle and to manage the grazing of the pasture. Fences act as a barrier to prevent cattle from leaving the fenced area. Fences provide a physical barrier to the movement of grazing animals, or they may be painful to animals that come in contact with them. With the proper training of the animals, either type of fence will contain grazing beef animals.

Barbed wire fences have traditionally been used

as pasture fencing. Construction has been 3 or 4 wires on posts spaced 5 m (16 ft) apart. Barbed wire fences provide a physical barrier as well as a somewhat painful experience to animals that come in contact with it. Barbed wire is also unpleasant for the fence builder.

Recently high-tensile smooth wire has become readily available as an alternative material for fence construction. Fences constructed of high-tensile smooth wire are of similar construction to the traditional barbed wire fences. High-tension smooth wire produces a lower cost, stronger fence than barbed wire and is an easier material to work with.

A third option to consider when constructing pasture fencing is electric fencing. Electric fences may be permanent or temporary. Permanent electric fences are used for boundary fences and predator control. Temporary electric fences are used to confine animals to one area of the pasture in order to set up an intensive grazing management system. Electric fences may have 1, 2, 3 or more wires depending on their function.

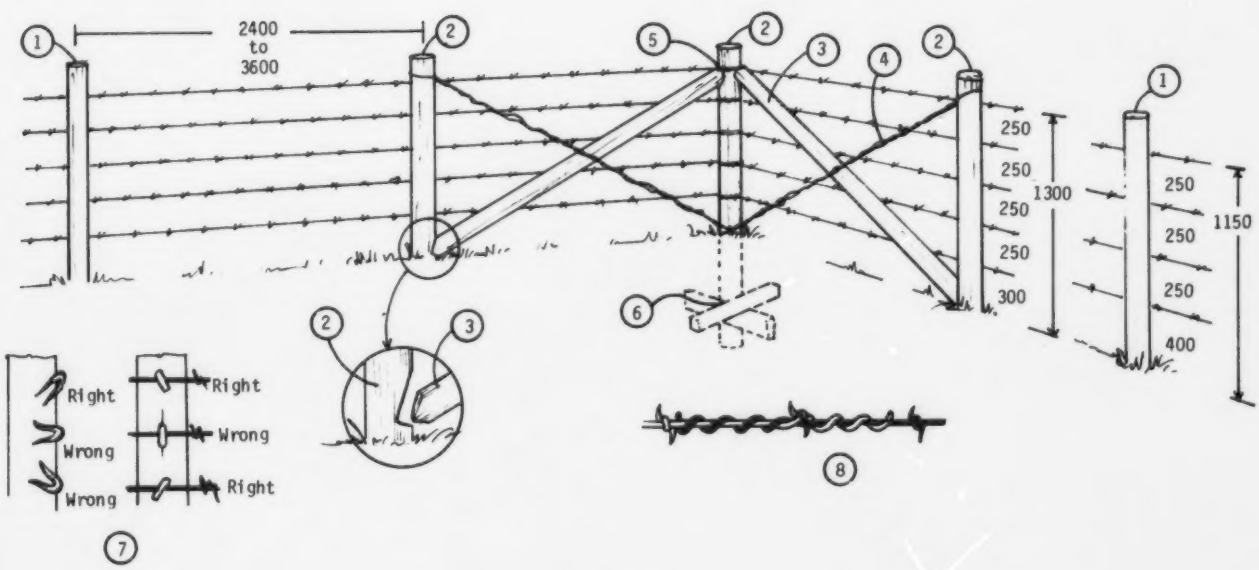


Figure 38 - Barbed wire field fencing.

1. 100 mm top diameter posts, pressure treated or commercial steel posts
   2400 mm long for 1500 mm high five row fence
   2100 mm long for 1350 mm high four row fence
2. 150 mm top dia. corner and brace posts
3. 100 mm diameter brace, notched and spiked into post No. 2
4. #9 guage brace wire, twist at two locations to tighten
5. Start wire at corner posts
6. Corner (and end) post anchors, wired and spiked to post
7. Fastening methods; galvanized metal staples (38 to 45 mm) should be driven obliquely at a slight downward angle, allow approx 3 mm play for movement of the wire through the staple
8. Wrap splice; the two ends to be joined are wrapped four times around the other.

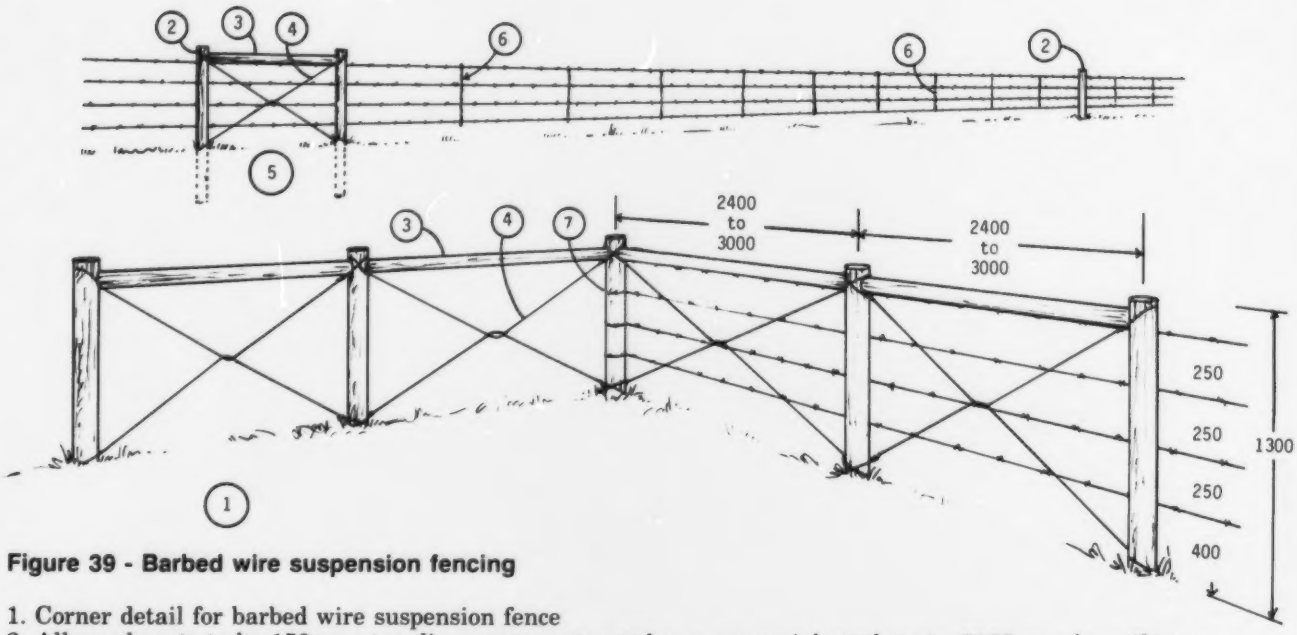


Figure 39 - Barbed wire suspension fencing

1. Corner detail for barbed wire suspension fence
2. All wood posts to be 150 mm top dia., pressure treated or commercial steel posts, 2100 mm long (fence posts to be 15 to 30 m on centre)
3. 100 mm min dia. brace rail
4. #9 guage brace wire (twist at center to tighten)
5. Stretch station at 180 m intervals
6. Wire twist-on stays @ 3600 mm on centre.
7. Start wire lengths from corner posts

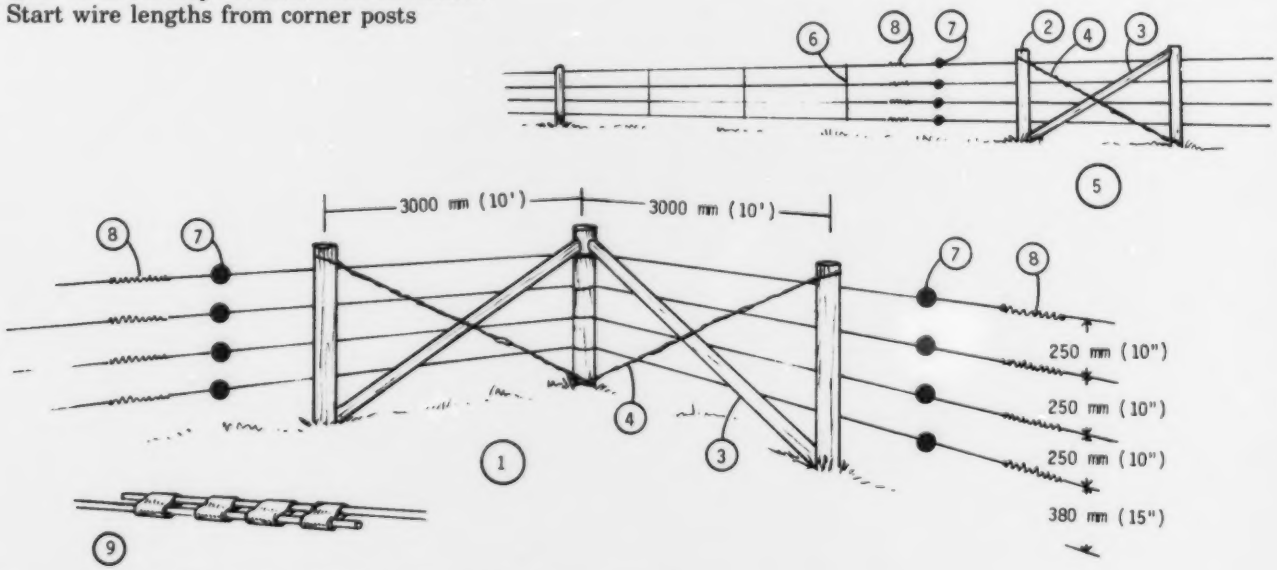


Figure 40 - High-tensile smooth wire (HTSW) pasture fencing

1. Corner detail for HTSW fence
2. Brace posts 150 mm x 2400 mm (6 in. x 8 ft) & pressure treated
3. Diagonal brace
4. Brace wire (HTSW), twist tighten
5. In line brace assembly
6. Stays
7. Wire tensioning winches
8. Tension spring assembly
9. Splice using crimped sleeves

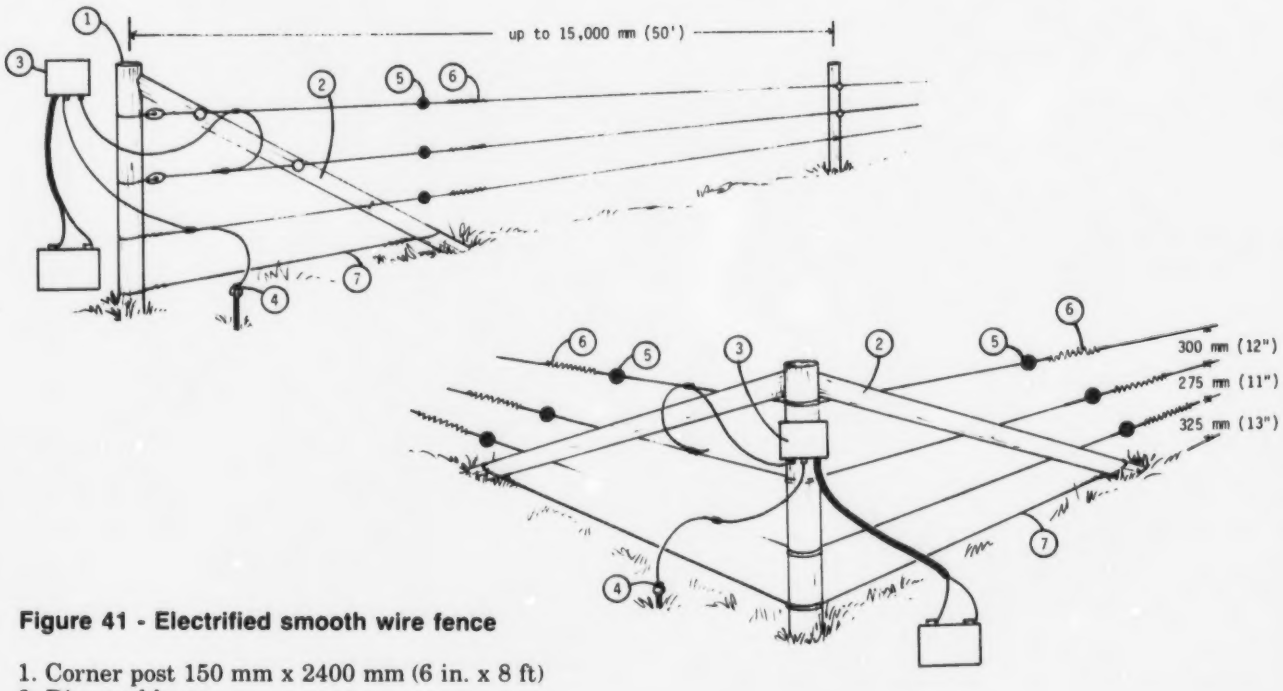


Figure 41 - Electrified smooth wire fence

1. Corner post 150 mm x 2400 mm (6 in. x 8 ft)
2. Diagonal brace
3. Energizer
4. Ground rod and wire
5. Wire tensioning winch
6. Wire tensioning springs
7. Brace wire

Fencing materials

Posts: Pressure treated posts are advisable. Posts are used for corner and end braces, and as line posts. Corners and end braces should be constructed of 150 mm (6 in.) top diameter posts. Line posts or pickets can be 75 mm (3 in.) or larger. When constructing suspension fences, stays or droppers are used. Stays or droppers may be wood, metal or plastic.

Wire: Barbed wire is available in either single strand high-tensile or in two strand styles. High-tensile smooth wire is available in 100 pound (45 kg) rolls in 12.5, 13 and 16.5 gauge. Twelve and one-half gauge high-tensile smooth wire is used for permanent high-tensile smooth wire fences. The 13 and 16.5 wire gauges are used for temporary and electrified fencing. Special lightweight conductors of wire and polypropylene with fine wires woven into it are used for temporary electric fencing.

Fencing hardware

Staples are used in the construction of both high-tensile smooth-wire fences and barbed wire fences. Special staples designed to allow the smooth wire to slide in the staple are available (it is important to staple wire fences so that the wire can slide freely in the staple). Connections in high-tensile smooth wire are made with sleeves or with "Reliable Wire Links". High-tension smooth wire fences must be tensioned to 250 to 300 pounds per wire. Hardware to tension the wire includes wire strainers and tension springs. Insulators and gate hooks are used to construct electric fences.

Electric fence controllers

Electric fence controllers generate a high current short duration pulse of electrical energy. The pulse of electricity energizes the fence and makes it a psychological barrier to livestock. On some electric fence controllers, the pulse duration and

Table 47
Spacing for high-tensile smooth-wire fencing

Fence application	Number of strands	Height of top wire from ground mm (inch)	Wire Spacing mm (in)									
			Grnd. -1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
Replaces 3 & 4 wire barbed wire	4	1010 mm 40 in.	380 15	200 8	200 8	230 9						
Pasture & Range fences	4	1160 mm 46 in.	380 15	250 10	250 10	280 11						
Moderate to heavy grazing situations	5	1140 mm 45 in.	400 16	180 7	180 7	180 7	200 8					
	6	1160 mm 46 in.	330 13	150 6	150 6	150 6	180 7	200 8				
Contains small & large animals, discourages some wildlife & dogs	8	1170 mm 46 in.	100 4	130 5	130 5	130 5	150 6	150 6	180 7	200 8		
*Replaces woven wire, contains most domestic livestock, discourages predators if 2nd & 4th wire electrified	10	1180 mm 47 in.	100 4	100 4	100 4	100 4	130 5	130 5	130 5	130 5	130 5	130 5

***Note:** Posts are drilled for wires or wires staggered on alternate sides of posts.

Table 48
Wire spacings for electrified fences

Fence application	Number of strands	Height of top wire mm (in.)	Wire Spacing mm(in.)			
			Ground-1	1-2	2-3	3-4
Single wire fence for subdividing pasture (cattle without calves)	1	750 mm 30 in.	750 30			
Two wire subdivision fence (for cattle without calves in dry locations)	2	900 mm 36 in.	500 20	440 16		
Three wire subdivision fence for confining cattle with calves	3	900 mm 36 in.	325 13	275 11	300 12	
Four wire fence for rotational grazing and pasturing different kinds of livestock	4	875 mm 35 in.	150 6	175 7	250 10	300 12

Note: It is recommended that all electric fences have warning signs posted every 100 m (330 ft) or less.

timing can be adjusted.

All electric fence controllers sold in Canada must meet Canadian Standards Association standard C22.2 No. 103-M1983 and subsequent amendments.

Electric fence controllers may be operated from 120 volt power sources, battery powered or solar powered. Most electric fence controllers are rated by length in kilometres of single wire fence that can be energized by the controller. For multiple wire applications, divide the rated length of fence by the number of strands to be energized.

Fencing practice

Fences are made up of many components: corner structures, end braces, gates, posts, wire and various hardware. Single and double corner and end braces are used. They are constructed of 150 mm (6 in.) by 2400 mm (8 ft) posts driven 1 m (3.3 ft) into the ground. For a stronger corner or brace, posts are driven to lean away from the pull of the wire.

Post spacing between end or corner structures depends on the type of fence. In non suspension fences, posts 75 - 100 mm (3 - 4 in.) in diameter are spaced every 5 - 6 m (15 - 20 ft). Suspension fences use posts spaced up to 20 m (60 ft) apart and droppers or stays every 3 m (10 ft). Electrifying the fence (never electrify a barbed wire fence) allows the post spacing to be increased up to 15 m (50 ft) and droppers can be eliminated. In rolling or uneven terrain, post spacings are reduced. In-line brace assemblies placed at major changes in slope make a stronger fence by reducing uplift forces on the posts.

Breaking electrical conductivity and grounding the fence will reduce livestock losses from lightning strikes to a fence miles away. Fences should be grounded every 50 m (165 ft) in dry soils and every 90 m (300 ft) in wet soils. Grounding is done by driving a galvanized steel rod or pipe 2 m (6 ft) into clay soils and 3 m (10 ft) into sand or gravel. In addition, electrical conductivity of the wire should be broken every 500 m (1650 ft).

Most electric fence energizers have built-in lightning protection. Damage can still result if lightning strikes, so an optional diverter and ground are recommended.

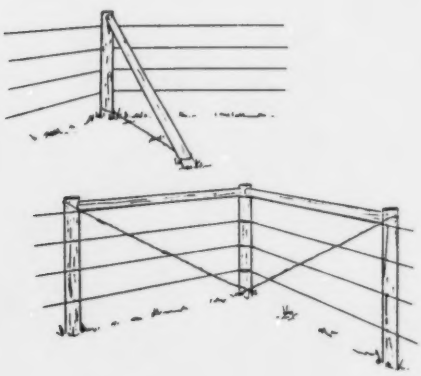


Figure 42 - End and corner structures

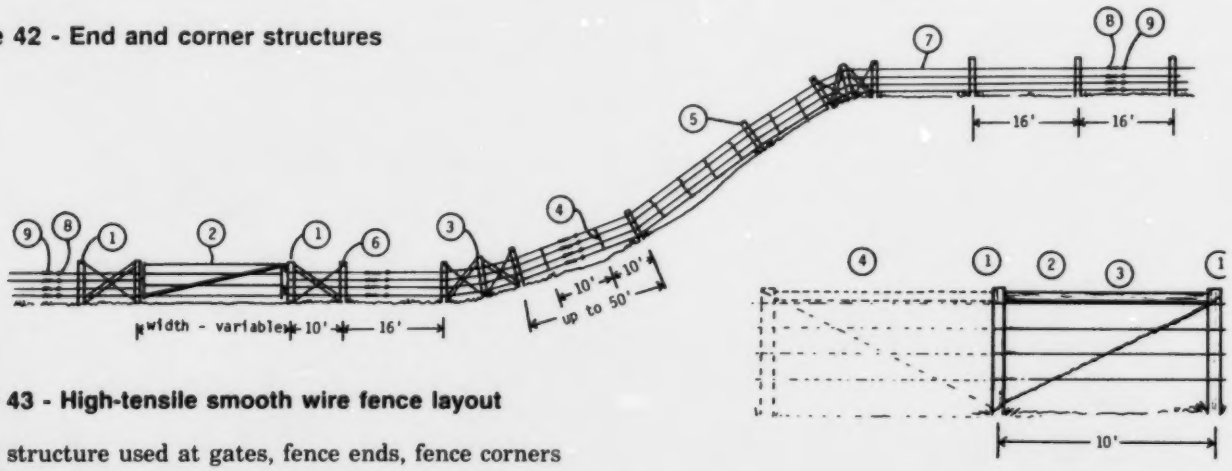


Figure 43 - High-tensile smooth wire fence layout

1. End structure used at gates, fence ends, fence corners
2. Gate
3. Fence brace - used every 1320 ft or at changes in ground slope
4. Stays (optional-spaced 10 ft on centre)
5. Line posts - 2 1/2 in. - 3 in. tops, 16 ft on centre
6. End structure and brace posts - 5 in. - 6 ft top
7. High tensile wire, 4 in., 5 in. and 6 in. wire spacing
8*Tension spring (250 - 300 lb tension)
9*Wire strainer (to adjust wire tension)

* Tension springs and wire strainers should never be placed within the brace structures but in mid span between the brace areas.

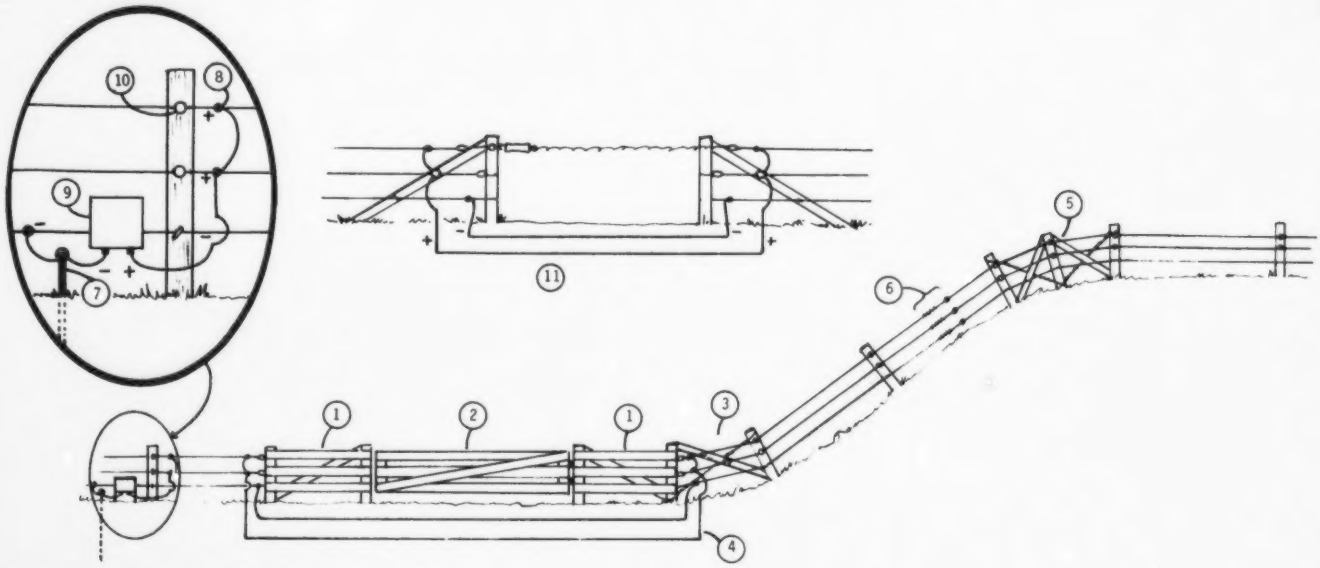


Figure 44 - Permanent electric fence

1. Rail or plank fence section
2. Wood or metal gate
3. End structure
4. Insulated wire to carry electricity across gate
5. Brace on changing slope
6. Wire tightening winches and tension springs
7. Ground rod
8. Connections to fence from energizer
9. Energizer
10. Insulators
11. Machine or man gate

Note: Make sure the gate for livestock is visibly different from the electrified fence so that the animals do not balk at going through the gate opening.

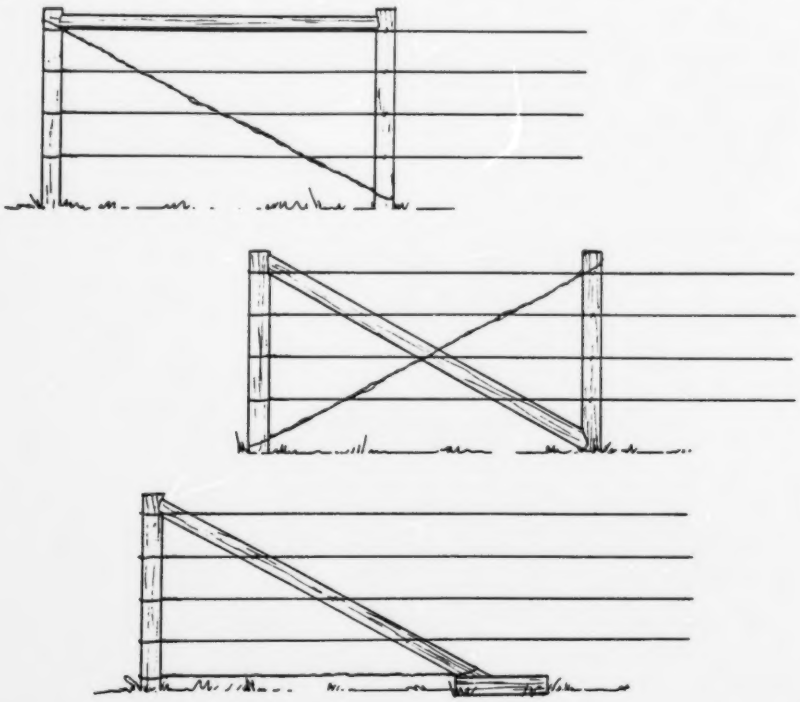


Fig 45 - Alternate end brace

Range and Pasture Management

Introduction

Range management is the care and use of range and pasture to get the highest continuous yield of animal products without endangering the forage plants, the soil, water resources and other important attributes of land. Animal products of the range are meat and hides.

The goals of range management are to:

1. Keep the range covered with good forage plants
2. Maintain a range feed reserve
3. Increase livestock production and wildlife
4. Increase the water-holding capacity and prevent rapid run off of water from the range
5. Control soil erosion.

A rancher must make a good estimate of how much of the range is over-stocked and how much is understocked. Understocking leads to an uneconomic operation. Overstocking will reduce the productivity of the range by reducing the palatable plants and increasing the weedy, unpalatable, nonproductive species. More rainfall and snowmelt will run off overgrazed range land because:

- there will not be enough vegetative cover to slow water flow,
- there will be less organic matter in the soil to absorb water, and
- compaction from trampling further reduces water infiltration.

The increased run off can cause soil erosion and reduce the moisture available for growth of forage species on the range.

Stocking rates

There are several terms which apply to carrying capacity.

Animal Unit (AU)—considered to be one mature 450 kg (1,000 lb) cow or the equivalent based upon average daily forage consumption of 11.8 kg (26 lb) of dry matter per day.

Animal Unit Month (AUM)—the amount of feed or forage required by an animal unit for one month.

Acres per animal unit month (Ac/AUM)—This term refers to stocking rate—the number of acres required to produce the forage required to feed an animal unit for one month.

Table 49
Animal unit equivalents

Bulls, 2 years or over	1.50
Mature cows with or without an unweaned calf	1.00
Yearling steers or heifers	0.67-0.75
Weaned calves	0.60
Yearling Horses	0.75
2 year old Horses	1.00
Horses 3 years old and over	1.50
5 Ewes or Does with or without lambs or kids	1.00
5 Rams or bucks	1.30
5 Weaned lambs or kids up to 12 months	0.60
5 Deer	1.00

Native range

Provincial range areas can be divided into six grazing zones (figure 46). The rangelands in Alberta vary with soils and climatic regions.

Needle-and-thread, blue grama range is the most important climax vegetation in zone 1. The annual precipitation is usually less than 356 mm (14 inches) and the mean annual temperature is over 3.3°C. Zone 1 is in the Brown soil zone. The average stocking rate is 4.2 acres per AUM.

Needle-and-thread blue grama, wheat grass range is the most important in zone 2. The annual precipitation ranges from 356 mm - 457 mm (14-18 inches). Zone 2 occurs in the Brown and Dark Brown soil zones. The average stocking rate is 3.5 acres per AUM.

Western porcupine grass, wheat grass range occupies zone 3 in part of the Dark Brown soil zone. The average stocking rate is 2.5 acres per AUM.

Rough fescue range is important in zone 4. The annual precipitation ranges from 457 mm - 610 mm (18-24 inches). The soils range from Thin Black to Black. The average stocking rate is 1.7 acres per AUM.

Parkland range occupies zone 5. It is characterized by aspen-poplar bluffs, intermixed with prairie varying from a fescue grassland to the western porcupine grass grassland. This is located on Dark Brown and Thin Black soils. The average stocking rate is 3.3 acres per AUM.

Brush pastures occupy vegetation zone 6. These are located on the Black and Grey Wooded soils of Alberta. The vegetative cover is characterized by

the presence of aspen, balsam poplar and willow trees. The average stocking rate is 5 acres per AUM.

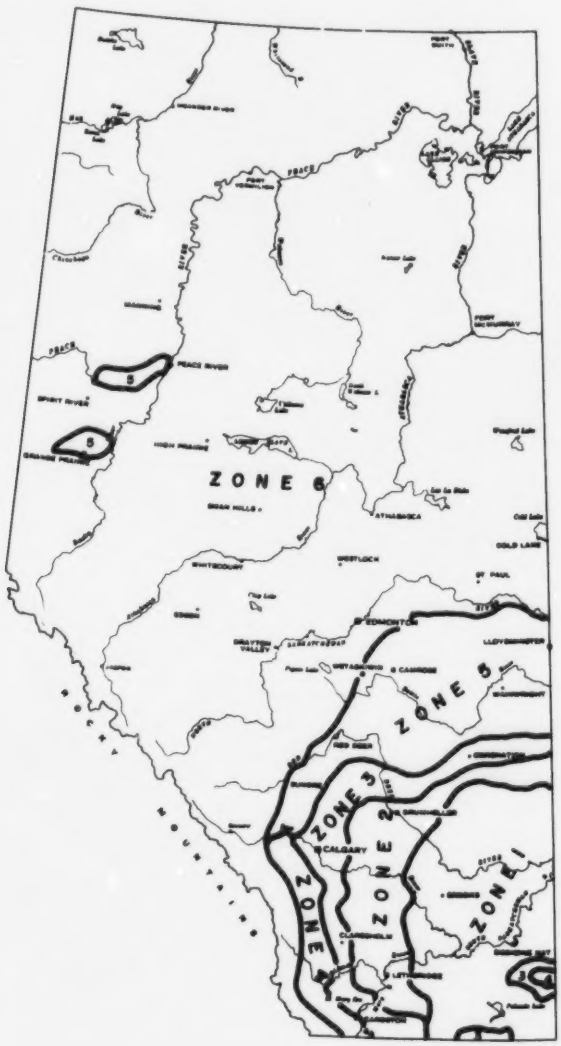


Figure 46 - Alberta range vegetation zones

Range conditions or range health is measured by how much the vegetation has changed from the original cover (i.e., climax vegetation). The greater the proportion of forage provided by the original or climax vegetation, the better the range condition.

Range conditions based upon the percentage of forage yield derived from climax plants can be classified as follows:

Excellent	75-100%
Good	50-75%
Fair	25-50%
Poor	0-25%

Stocking rates, with an allowance for carryover, are calculated so that range in excellent or good condition will be maintained, while those in fair or poor conditions will be improved.

Most ranchers manage their lands to improve forage condition if it is below good. The stocking rate values (table 50) apply to average sites and average climatic conditions. There is considerable variation in stocking rates within each zone depending on slope, range condition and the presence or absence of tree cover.

Tame pastures

Tame pastures are generally used in conjunction with rangeland. Excellent and good condition stocking rates (table 51) represent the production encountered in an acceptable stand of a pasture mix of adapted grass and legume species.

Fair condition stands represent a situation where production is low enough that the pasture should be appraised critically. Can the production be improved by modifying grazing practices, is fertilization necessary, should the pasture be cultivated and reseeded?

Poor pasture condition represents a stage where production is low enough that there is no alternative but to renovate by cultivating and reseeding. This represents a pasture where the desirable species have been replaced by undesirable ones. It may be a pasture with a large population of weeds or where the good forage plants have been grazed out.

The stocking rate in table 51 applies to average soils and climatic conditions. There may be variation in stocking rates in each zone as a result of variations in rainfall and soil conditions.

Table 50
Stocking rates for Alberta native range in acres per animal unit month (Acres/AUM)

	Range Condition			
Zone	Excellent	Good	Fair	Poor
1. Needle-and-thread, blue grama type	3.5	4.2	5.2	7.5
2. Needle-and-thread, blue grama, wheat grass type	2.7	3.5	4.2	6.2
3. Weatern porcupine grass, wheat grass type	2.0	2.5	3.2	4.2
4. Rough fescue type	1.2	1.7	2.5	3.2
5. Parkland type	2.7	3.3	4.2	5.8
6. Woodland pasture type	4.0	5.0	6.0	8.5

Table 51
Stocking rates for Alberta tame pastures in acres per animal unit month (acres/AUM)

Zone	Pasture Health			
	Excellent	Good	Fair	Poor
1	1.3	2.0	2.7	4.0
2	1.0	1.5	2.0	3.0
3	0.7	1.0	1.3	2.0
4	0.5	0.7	0.9	1.4
5	0.3	0.5	0.7	1.0
6	0.3	0.5	0.7	1.0
Irri.	0.2	0.3	0.4	0.6

How to Use tables 50 and 51—You can use the stocking rate table in estimating the carrying capacity of your range or pasture.

Suppose your land is in zone 1 near Medicine Hat. After examination the range is found to be in good condition with above-average site quality.

Locate zone 1 in table 50 and read across the range condition classes until the good condition column is reached. Under good condition in zone 1 the stocking rate indicated is 4.2 acres per animal unit month. If grazing for 100 cows for five months is required, the range needed would be 5 months x 4.2 acres x 100 animal units = 2,100 acres.

If a pasture of 600 acres of good condition range in zone 1 were to be stocked, 600 ÷ 4.2 = 143 AUMs could be harvested each year. This works out to be 143 ÷ 5 = 29 AUs for 5 months, or 143 ÷ 6 = 24 AUs for 6 months.

If yearlings are to be grazed the number can be calculated by dividing the animal units for 5 months (i.e., 29) by 0.67 (1 yearling = 0.67 to 0.75 AU). 29 AU divided by 0.67 = 43 yearlings for 5 months.

Similarly, on tame or irrigated pastures the same method may be used using the stocking rates in table 51.

Example 100 acres irrigated pasture rated good: 100 divided by 0.3 = 333 Animal Unit Months or 333 divided by 4 = 83 cows or Animal Units for 4 months.

Table 52
Conversions of AUMs per acre to acres per AUM

AUM per acre	Acres per AUM	Acres for 6 months	Acres for 9 months	Acres for 12 months
.1	10.0	60	90	120
.15	6.7	40	60	80
.2	5.0	30	45	60
.25	4.0	24	36	48
.3	3.3	20	30	40
.35	2.9	17	26	34
.4	2.5	15	23	30
.45	2.2	13	20	26
.5	2.0	12	18	24
.6	1.7	10	15	20
.7	1.4	8	12	16
.8	1.3	7	11	15
.9	1.1	6.6	10	13
1.0	1.0	6.0	9	12
1.2	.8	4.8	7	10
2.0	.5	3.0	5	6

Table 52 shows the stocking rate conversions of AUMs per acre to acres per AUM, acres for 6 months, acres for 9 months, and acres for 12 months. The stocking rate expressed on grazing leases is usually in acres per animal unit grazing for 12 months.

Grazing Management

Carryover

Carryover is the amount of forage that is left when grazing ends. On native range it should be 45 per cent of the current growth, and 20 per cent of the seed stalks should remain uneaten. Green plants manufacture their own food; when they are grazed moderately some of this food is used for further growth and some is stored in the roots. The food manufacturing process stops when all the leaves are removed. Plants then depend on root reserves to produce new growth and die if reserves are depleted. Leaving adequate carryover assures there are adequate root reserves to maintain yield in the following year.

A carryover of 45 per cent each year is impractical because production varies from year to year. This variation may range from 35 to 250 per cent of average production of forage. The 45 per cent carryover is an average value which the proper stocking rate will yield over a period of years.

The need for carryover on tame pastures is not as critical as with native range. Instead a utilization of 70-75 per cent is considered proper use. This is usually estimated by average stubble height when the cattle are rotated. Although proper use according to height varies as to species sown, a rule of thumb is to remove the cattle when the average stubble height in the pasture reaches 75-100 mm (3-4 in). Continual overgrazing causes depletion of food reserves resulting in a reduction of the stand.

Grazing season

To maintain condition, native range grazing should be delayed until the grasses have produced green leaves and are manufacturing and storing food, unless a surplus stockpile of previous years growth has been accumulated. Thus range readiness varies from year to year. Dates of readiness for grazing can be linked with the flowering of well-known plants. For zones 1, 2, and 3, grazing should not start until the buffalo bean is in full

Table 53
An example of a deferred rotation

Pasture	First year Spring	First year Summer	First year Fall	Second Year Spring	Second Year Summer	Second Year Fall
No.1	Grazed	Ungrazed	Grazed	Deferred	Grazed	Grazed
No.2	Grazed	Ungrazed	Grazed	Grazed	Ungrazed	Grazed
No.3	Deferred	Grazed	Grazed	Grazed	Ungrazed	Grazed

flower, usually in late May. For zone 4, range is ready when the shooting star is flowering, and for zone 5, the native rose.

Another reason for delaying grazing in the spring is that different grass species start growth at different times which may vary by as much as 6 weeks. Also, the longer grazing is delayed in the spring the greater the forage yield.

In some cases it may be impractical to delay grazing until late spring, especially if no other livestock feed is available. The negative effect of this may be minimized through changes in management. Ranchers may adopt a grazing system or rotation that allows them to use different fields for spring grazing in consecutive seasons. Another common practice is to reseed areas to early growing species of tame grass, such as crested wheat grass, for spring use.

Grazing systems

Any consideration given to grazing systems or a rotation should include objectives such as improvement or maintenance of range condition, increased stocking rate or improved animal performance.

Forage production on native land may be increased by improving the health or condition of the range. Range condition is the state and health of the range based on what the range is naturally capable of producing. A common practice for upgrading range condition is to rest an area for one full season. A more economic approach is to defer grazing in the spring and graze it late in the season.

One of the reasons for using a grazing animal to harvest forage is that this method is inexpensive. This advantage, however, may be lost because of uneven utilization. A grazing animal will tend to graze patches and leave other patches ungrazed. A system that allows larger numbers of grazing animals on an area for a short time is advantageous because it forces animals to utilize the area more uniformly.

Rotational grazing systems are especially useful for tame pastures because they maximize rest periods, which increases plant regrowth rates and over all yield.

Table 53 gives an example of a deferred rotation. The object is to obtain spring grazing from native range as well as maintain or improve the range condition. It allows each field to rest in the spring or summer season once every three years. Each field is always grazed in the fall when the range is least susceptible to grazing damage. Any grazing system has to be designed to suit an individual ranch operation.

Where range conditon is good and where no serious distribution problems exist, the rotation shown in table 53 was found to be no better than continuous summer use (Manyberries Research Station).

Grazing distribution

When grazing animals are used to harvest a forage crop, they must be manipulated to graze as uniformly as possible. If left to their own devices, livestock will continue to graze small areas and keep them closely grazed while leaving other areas relatively untouched. The tools available to achieve more uniform grazing include water supply locations, salt and mineral locations, fencing, cattle oilers or rubbing post locations, shelter locations and herding cattle to unused portions of range.

The objective in developing water supplies is to provide a more even distribution of animals over the range, and thus use areas that would be wasted because of lack of water. Cattle should not have to travel farther than 3 km in flat country and no more than 0.8 km in rough country. Natural water supplies can be improved by cleaning out and preserving springs, seeps and ponds. Development can include drilling wells and constructing reservoirs.

Salt and mineral location is another tool used to obtain better grazing distribution. Animals usually seek out salt. Therefore, to improve distribution, salt and mineral should be placed away from water in areas where animals are not grazing. If moved periodically, the animals usually follow the salt.

Cattle oilers, rubbing posts and shelters can be placed strategically to improve distribution in a field.

Fencing will facilitate grazing rotations to improve grazing distribution. The first requirement is to restrict cattle to the grazing land. The second is to force livestock into areas not usually frequented. Uniform grazing is one of the advantages of the various short duration grazing systems where eight or more pastures may be used. Short duration grazing also provides a rest period for pasture which is important in maintaining high yield and good condition.

Range improvement

The objective of range improvement is usually to improve the quality and quantity of forage for increased animal production. The methods available are numerous, but sowing timothy, creeping red fescue, alsike and red clover is important in the Black and especially in the Grey Wooded soil zones. Orchard grass is adapted to Black and Grey Wooded soils where there is a reduced likelihood of winterkill.

Fertilization

Fertilization of native range is not usually recommended because most range areas contain a mixture of grasses, broadleaved plants and shrubs. Much of the fertilizer is utilized by plants not grazed by cattle. Research on prairie rangeland has shown that where moisture is adequate, increased yields are realized but usually not enough to make fertilizing an economic operation.

On tame grass stands nitrogen fertilization is important, and rates that give the most economic response vary depending on the average annual precipitation, varying from uneconomic in the driest areas to economical at rates of 100 lb/acre or more of actual nitrogen in moist areas. For high annual applications of nitrogen, split applications can be considered.

Tame pastures with a high legume component (for example 50 per cent legume) require less nitrogen but attention must be paid to phosphorus fertilization. In all cases, soil testing should be used as a guide to fertilization practices.

Reseeding

Research has shown that production can be increased three-fold by reseeding native range with adapted tame forage species on the better soils in the prairie areas of Alberta.

Reseeding can also be used to provide a more reliable supply of forage. Range production can vary from year to year depending on May-June rainfall. In normal years the increased production from some of the reseeded fields can be harvested as hay. When grass production is low because of a dry spring the reseeded pastures can carry the herd without the need to sell off some of the breeding stock.

The first consideration when reseeding in dry areas is to establish spring pastures with crested wheat grass or perhaps Russian wild rye. Native range is not well suited to intensive spring use because it is easily damaged. Crested wheat grass is ready for grazing some six weeks earlier than native prairie and produces 90 per cent of its annual yield before July 1. Native range will yield more when used as summer and fall pasture as opposed to spring pasture. Crested wheat grass is excellent for spring pasture, but it tends to become less palatable later in the season. Generally, because of Crested wheat grass's limited season of use, no more than 20 to 25 per cent of a ranch unit should be seeded to it. Russian wild rye also starts growth early in the spring but remains palatable long into the fall. Russian wild rye has proven to be outstanding for summer and fall pasture and retains a relatively high nutritive value in late summer and fall. Many ranchers consider the extra year it takes to establish a stand to be compensated for by the versatility of Russian wild rye grass.

Altai wild rye and dryland alfalfa varieties are also useful in dry areas (e.g. Brown soil zones).

Pubescent wheat grass, intermediate wheat grass, smooth and meadow brome grass and alfalfa are useful in the Dark Brown, Black and Grey Wooded soil zones.

Meadow foxtail, reed canary grass and to some extent timothy, creeping red fescue and alsike clover are useful in peaty and other low lying areas.

Orchard grass, brome grass, timothy, Kentucky blue grass, alfalfa and white clover are commonly used for pasture in irrigated zones

The most useful species for rapid regrowth are orchard grass, meadow brome grass, meadow foxtail, creeping red fescue and legumes, especially alfalfa. They respond well to intensive management.

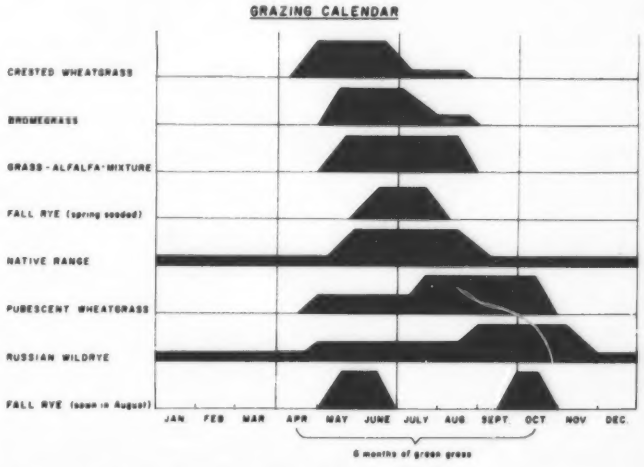


Figure 47 - A grazing calendar

The principle in range reseeding is to kill all existing vegetation and seed the forage species into a firm seedbed on fallow or stubble in the fall or early spring. Row spacing is important in prairie areas. Crested wheat grass sown at a 45 to 60 cm (18 to 24 in) row spacing will yield much more

forage than the same grass sown at 15 cm (6 in) rows in the Brown soil zone. Recommended row spacing is shown in table 54. Stands of tame forage with wider row spacing usually remain productive for a longer period of time than stands established by solid seeding. Crested wheat grass has remained productive for 40 years with an appropriate row spacing.

Table 54
Row spacing recommended for range reseeding

Vegetation zones	Spacing in cm	Spacing in inches
1	45-60	18-24
2	30-45	12-18
3	30-45	12-18
4	15-18	6-7
5	15-18	6-7
6	15-18	6-7

Annual crops

Annual crops may be used to supplement forage production of perennial pastures or used as emergency pasture. Crops such as oats, barley, fall rye, spring seeded winter wheat, winter triticale, annual rye grass and forage kale can be used where they are adapted. Fields may be divided into smaller paddocks with temporary fences (e.g. electric fences). The cost of annual pasture is higher than for perennial tame pasture i.e., it is comparable to the cost of growing cereals for grain.

Brush pastures

Brush pastures that occupy vegetation zones 5 and 6 are also used for raising cattle. However, the grazing season is short. The native plants produce little forage before the middle of May or beginning of June and lose their nutritional value after the first killing frost.

Native forage plants in brush covered areas do not tolerate heavy use. The palatable forage plants will be grazed out if grazing is too heavy.

Range improvement in the form of reseeding becomes important to increase grazing production. Because of the high cost of clearing and breaking, the best soils should be selected to be seeded to improved grasses and legumes. Large scale projects using rough or once-over methods are seldom successful owing to poor forage establishment and the woody regrowth. Clearing and breaking projects using annual grain cropping for one or two years to ensure adequate brush removal and to partially defray the expense are recommended. In some cases, it may be useful to suppress brush using chemicals.

When managing a combination of tame pasture and native range, it is usually more efficient to graze tame pastures in separate fields. Research at Manyberries, however, shows that when crested wheat grass, Russian wild rye and native range are available in the same field; livestock will selectively graze each species in different seasons when each is most palatable.

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